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Foundry Standardizes Nickel Alloy

Molds for Monel Metal Castings Are Made of Silica Sand and Gated Similarly to Those Made for Steel — Large Risers Are Used — Electric Furnaces Will Supplant Old-Style Melting Mediums

BY H. E. DILLER

TWO main divisions comprise the entire castings industry according to the commonly accepted classification. Castings made of gray iron, malleable iron or steel are placed in one broad group, while in the other division are placed all those made of nonferrous alloys. These two general classifications differ widely in the nature of melting mediums employed. Nonferrous castings almost invariably are made from metals which have a lower melting point than either iron or steel. Also, in some cases nonferrous metals and alloys are volatile at low temperatures.

These properties necessitate melting mediums which will give readily controlled heat together with a temperature which is not too great. Further, the heat source in nonferrous furnaces should not be localized at any one point as this causes burning or oxidation. For these reasons, crucibles or resistance and indirect-arc type electric furnaces, are more commonly used in nonferrous melting where low melting-point alloys are employed. Copper, the basis for many nonferrous alloys, melts at several hundred degrees, Fahr., below the melting point of iron or steel, and in many instances is alloyed with tin, zinc, lead, aluminum or antimony, all of which are much more easily fused.

An Exception Noted

Nickel offers a marked exception to the nonferrous metals commonly used for castings. This metal has a melting point approximately the same as medium carbon steel and even higher than gray or malleable iron. When alloyed with other metals such as copper and zinc to make nickel silver its melting point is considerably reduced. This also is true when nickel, alloyed with copper and a small proportion of iron and other metals, makes what is known as monel metal. Even this alloy melts at a temperature only slightly less than medium carbon steel and somewhat higher than gray iron. This temperature is 2480 degrees Fahr.

Monel metal is a comparatively new alloy, having been introduced into industry about 15 years ago by the International Nickel Co., New York, and was named after Ambrose Monell, a member of the company. At first this metal was developed most extensively in rolled products. Later the forging and casting fields were entered and companies were promoted to manufacture castings of monel metal, and to extend the use of the alloy in this direction. About six years ago two companies which had been making monel metal castings for some time were consolidated under the name of the Bayonne Casting Co., Bayonne, N. J. This company is a subsidiary of the International Nickel Co. and is used to study

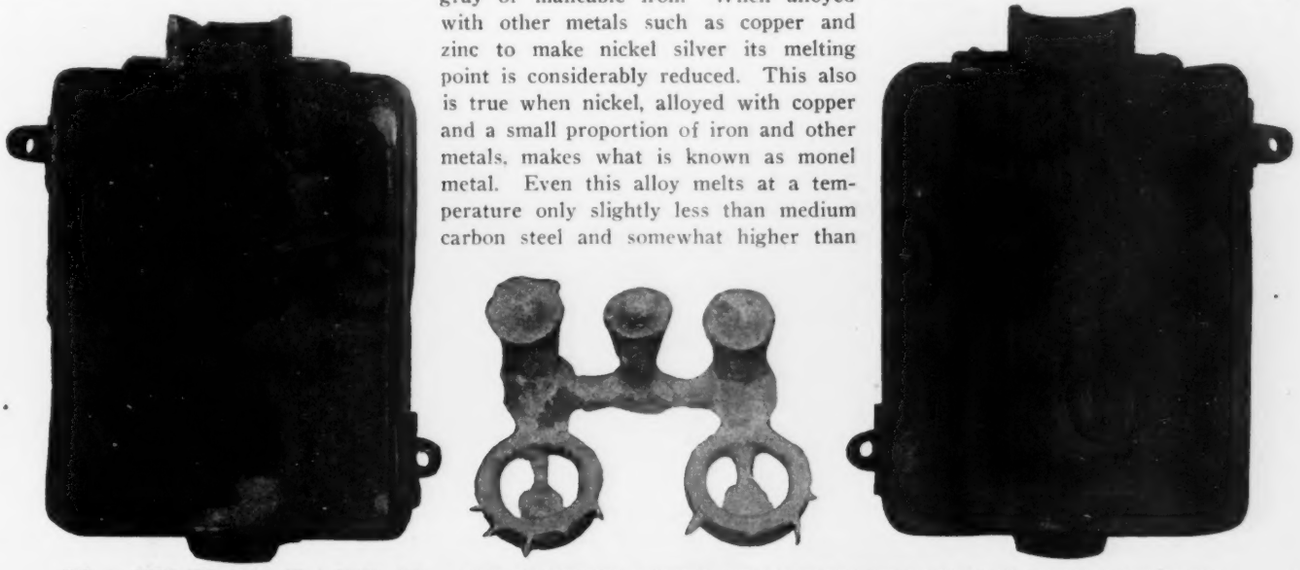


FIG. 1—COPE AND DRAG OF A MOLD AND A GATE OF CASTINGS SHOWING THE LARGE PROPORTION OF METAL IN GATES AND RISERS

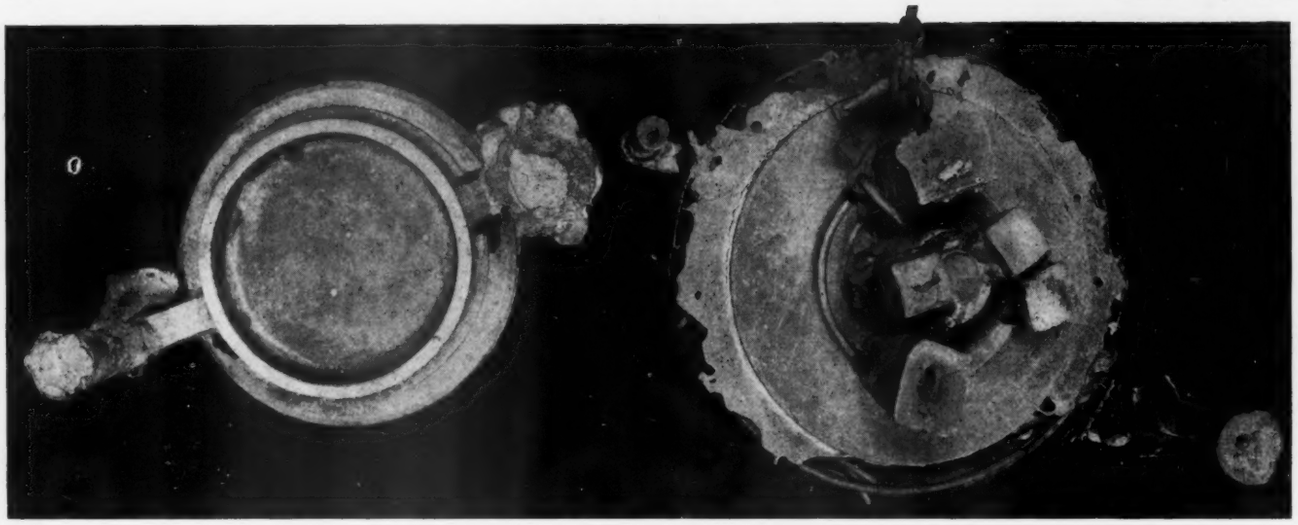


FIG. 2—THESE CASTINGS INDICATE THE METHOD OF GATING MONEL METAL AND SHOW THE LARGE RISERS NECESSARY

process of manufacture and promote the use of monel metal generally. Recently the name of the company has been changed to the Monel Metal Products Corp. and the metallurgical staff has been increased to broaden the services of the metal.

With the years of study which this company has put on casting monel metal, the finer points of the process have been developed. Some slight changes in the composition of the metal have been suggested to the International Nickel Co., so that now the casting metal made is slightly different in composition from the monel metal made for rolling. Ingots are furnished to the Monel Metal Products Corp. ready for melting and casting without any change in their composition. This new metal with approximately 40 per cent scrap metal in the form of gates, risers and defective castings, makes up the charge for a heat.

Melting is Difficult

While melting and casting an alloy of the proper composition might seem simple, those who have had experience with nickel or its alloys know the difficulties which confront the inexperienced. Therefore, the foundry at Bayonne is maintained partly to help other foundries who wish to start making monel metal, and to enable them to turn out castings which will uphold the reputation of the alloy. Inferior quality, it is said may be avoided by proper melting and casting practice.

At present two types of melting units are employed at the Bayonne foundry. One is a pan-type oil furnace and the other is a small arc-type electric furnace. The oil furnaces will be discarded in the near future when it is intended to install a two-ton electric furnace either of the arc or resistance type. However, the oil furnaces are of interest as they are not generally known to foundrymen. There are four of them; two have a capacity of 3000 pounds each, while the other two will melt 7200 pounds of metal each. The bodies of the furnaces are steel plates bound together by steel bars. The sections are set on rollers and thus

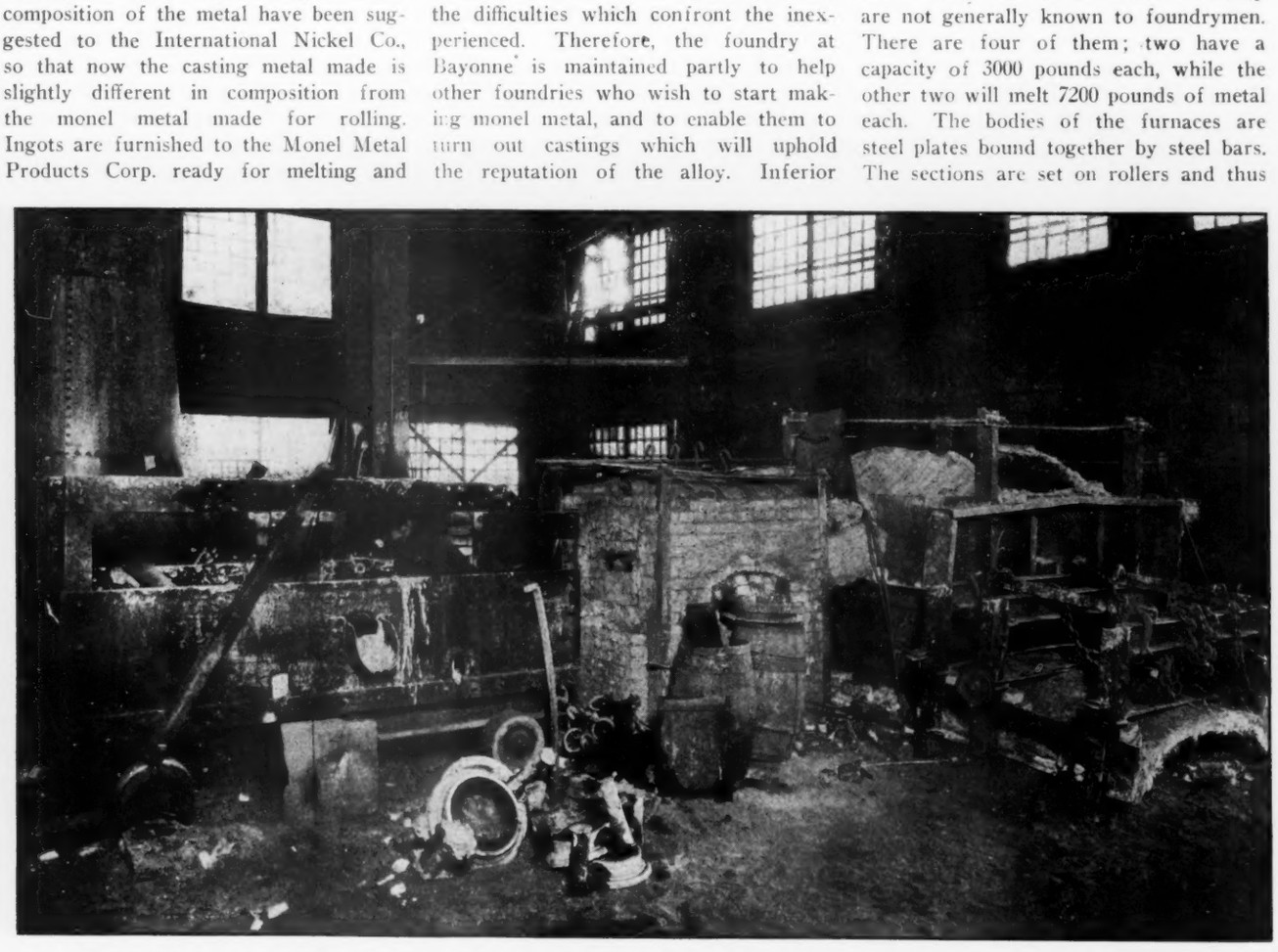


FIG. 3—THE FRAME OF A FURNACE TO THE LEFT IS BEING LINED PREPARATORY TO USE—IT WILL BE CONNECTED TO THE STACK THROUGH A PORT IN THE BRICK COLUMN BESIDE IT

may be moved about much more readily.

Near the center of the foundry is a column built of firebrick as shown in Fig. 3. This column is hollow and acts as a flue leading to the stack shown at the left. As may be noted on two sides, arched ports are bricked up. One of these ports is built into two sides of the dust-chamber column. When it is decided to connect a furnace the steel body is brought in from the yard where it is kept and placed in position near the flue. The body is then bricked up with firebrick and connected with the flue by a firebrick port after removing the brick which close the hole in the column leading to the stack. The bottom of the furnace is made of firebrick grouted with fireclay. Two furnaces may thus be attached to the central flue at one time.

Heat is obtained from the flame from four pans of oil placed in the rear of the furnace. Air is drawn over these pans by the draft in the stack. The air passing over the pans of ignited oil produces a flame which enters the melting chamber. The more air that is drawn over the oil the more oil is burned. This gives a balanced condition to the flame and automatically prevents it from becoming oxidizing and burning the metal. As oxidation is a serious factor with nickel and its alloys this feature of the furnace is a decided advantage.

A Snyder electric furnace was purchased by the company some months ago. This is a hand controlled furnace of the single phase type and therefore has but one electrode, as may be noted in Fig. 4. The rated capacity of the furnace is 750 pounds, but it has been found that 1000 pound heats may be melted advantageously.

As shown in this illustration, an unusual roof has been built for this furnace. This roof is formed of ganister and silica brick. A circle of bricks forms the opening through which the electrode extends. Another circle of brick is built around the outer edge of the roof, but this circle has layers of ganister between the brick as is indicated in Fig. 4. The space between these two brick sections is filled with ganister. No tie rods are used in the construction of this roof and the combination of silica brick with ganister has proved highly satisfactory. In addition to the advantage of long life, this roof forms a comparatively air tight cover, with the exception of the hole around the electrode. This is important due to the necessity for keeping the metal from becoming oxidized. The efficiency of the means employed to render the furnace air-tight may be seen from Fig. 4. No gas is escaping except around the electrode. All other cracks or crevices are luted tightly with fireclay and even the tapping hole is stopped with a piece of brick and then luted with clay.

Air Kept Out

Metal is charged through the top of the furnace after the cover has been tilted back. When the furnace is full the cover is lowered and the tapping hole is closed. Then the spout and cover rim are daubed with clay. After the charge is melted down, more metal is added to the furnace through the tapping hole. While doing this the current is turned off. When enough metal has been charged, the tapping hole again is closed and the current turned on to finish melting. After the metal is melted and has become superheated to about 2800 degrees Fahr., the cover is removed from the tap hole. The end of a pole of green wood then is immersed in the bath to produce a boil. This action together with the reducing effect of the wood deoxidizes the metal. Usually about three minutes are required to attain the proper deoxidization. One of the sticks which has been used for poling is shown at *A*, Fig. 4. When it is estimated that the metal is sufficiently poled, the tap hole again is closed and luted and the current turned on to heat the metal for pouring. The proper temperature has been found to be about 2800 degrees Fahr. When it is judged that this temperature is reached a sample is taken in the spoon shown at *B*, Fig. 4, and poured into the sample mold, *C*. The manner in which this button sets indicates whether the metal has been sufficiently poled and the way it pours together with the time required for it to freeze show whether the correct pouring temperature has been reached. An experienced melter will thus know whether the metal is hot enough for pouring and a pyrometer is needed only occasionally in special cases. If the button indicates that the metal needs more poling this is done and then more heat is required. In this event or if the metal is too cold, the tap hole again is closed and the current turned on for the length of time judged necessary to bring the metal to the proper temperature for pouring. On all

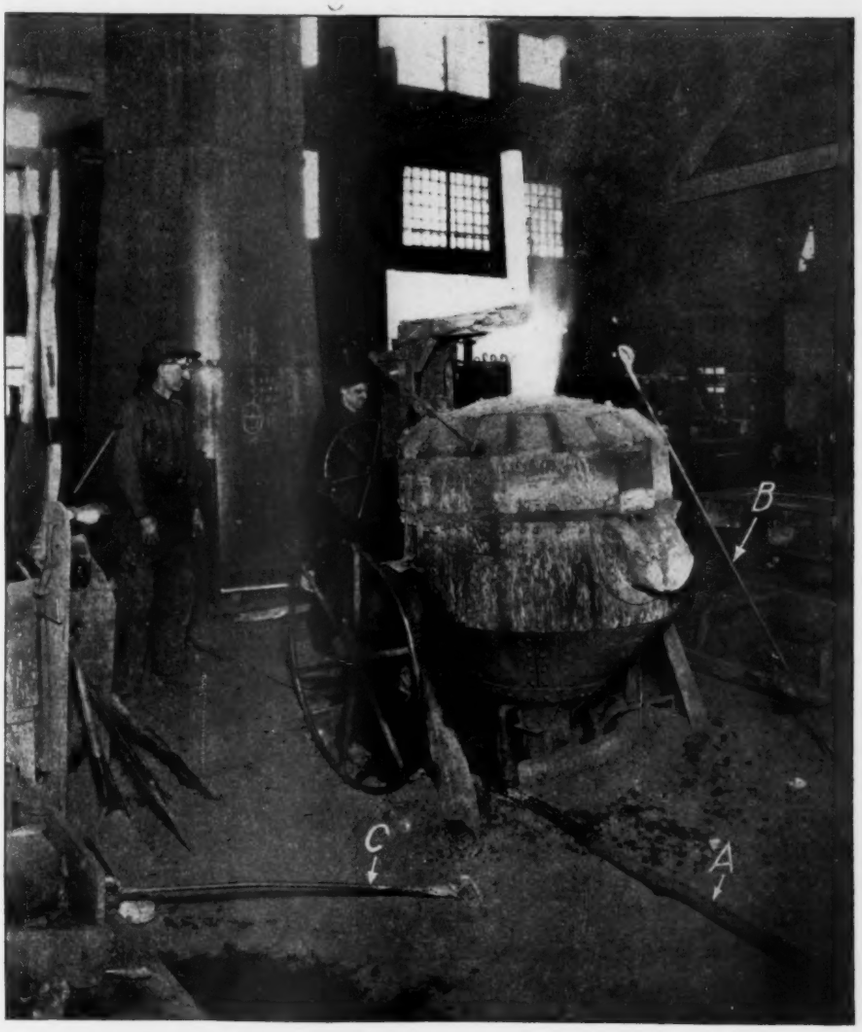


FIG. 4—AN EXPERIMENTAL ELECTRIC FURNACE HAS PROVED SO SUCCESSFUL THAT IT HAS BEEN DECIDED TO INSTALL A LARGER ONE OF 2 TONS CAPACITY

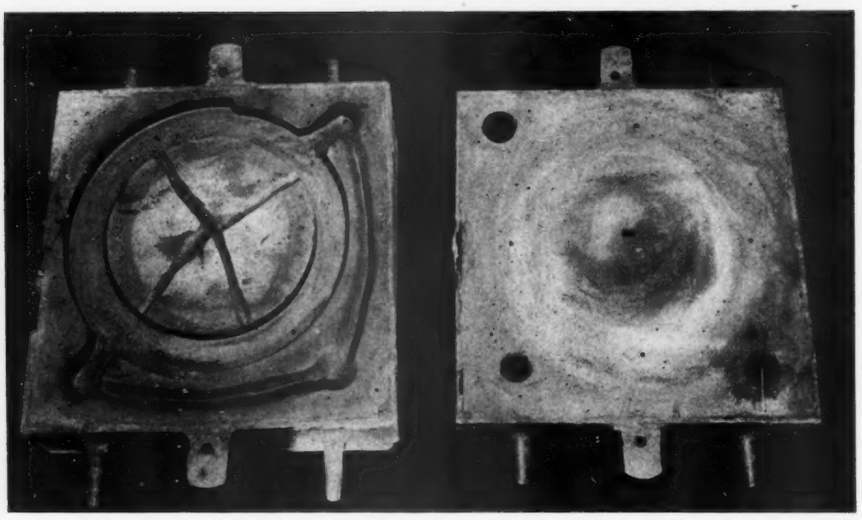


FIG. 5—THE ARRANGEMENT OF THE GATE ALLOWS THE SLAG AND DIRT IN THE METAL TO RISE TO THE SURFACE AS IT FLOWS THROUGH THE RUNNERS AND TO PASS UP INTO THE RISERS

occasions the tap hole is daubed with clay as soon as possible to prevent oxidation. A long narrow sample, about 1 inch wide, is bent and broken to test its malleability and to study the structure of the fracture. Should either of these tests show defective metal the fault must be corrected before pouring.

Monel metal is poured into bull ladles from the furnace for casting. It is further deoxidized in the ladle by the addition of magnesium. This is held under the surface of the metal by tongs. For a 100-pound ladle, 1½ ounces of magnesium is added. Proportionately more magnesium is used for larger amounts of metal.

The temperature at which monel metal is poured demands a different kind of molding sand than that generally employed for nonferrous alloys. This sand is the same as is used for steel castings. It is obtained from the Lumberton district in New Jersey and from the Albany district in New York. In other ways the molding resembles molding for steel castings. The shrinkage of monel metal, being ¼-inch per foot, is the same as the shrinkage of steel and necessitates heavy risers on the castings to feed in new metal during the cooling period. The extent to which risers are necessary may be judged from the castings in Figs. 1 and 2.

The casting to the right in Fig. 2 is an impeller for a turbine. The rodding for one of the cores may be noted around the edge of the casting. It was poured from the two gates shown around the circumference and five risers were provided as may be seen. These risers were near the center of the casting, where the heaviest section of metal was situated. The casting to the left in the same illustration is a disk for a gate valve on a water main. The section of this casting was more regular than the section of the impeller and only one riser was necessary. The casting was poured from a gate at one side and the riser was located opposite the gate.

The method of gating small castings may be noted from Fig. 1, which shows in the center a gate seat ring for a valve. Here the gate and risers required more metal than the castings. Other castings are differently proportioned to the gates and risers so that usually half of the metal melted goes into good castings and the other half is accounted for in gates and risers, defective castings and melting loss.

In making the mold the facing sand is mixed with binders of clay, flour and pitch. The backing sand is dampened with molasses water to bind it. Cores are made of sharp sand with an oil binder and covered with silica wash. The molds are skin dried but not baked. A cope and drag for a valve seat ring after it had been skin dried is shown in Fig. 5. This is poured through the gate in the corner. The metal flows through the two runners to opposite corners of the flask as shown in the drag. From these corners it flows into the mold and into a riser at each corner, where a riser is located. Coming through the gate and flowing along the runner any slag or sand in the metal has an opportunity to rise to the top as soon as it reaches the gate at the mold. Instead of going into the mold, dirt is carried up into the riser.

Much of the molding is done on the floor without machines but several molding machines are employed for certain classes of work. Two jar-ram machines of the Mumford type were furnished by the Dayton Molding & Machine Co., Dayton, O. The company also has a jar-ram machine supplied by the Tabor Mfg. Co., Philadelphia and a rollover machine built by the Osborn Mfg. Co., Cleveland. Chaplets used are made of monel metal.

Locate Service Stations

Service stations of the Hauck Mfg. Co., 101-113 Eleventh street, Brooklyn, N. Y., located at Boston, Pittsburgh and Cleveland have been moved to larger and better-located quarters. In Boston the service station has been moved from 70 High street to 149 Berkeley street; in Pittsburgh the station has been moved from 2930 Penn street to 105 Wood street; in Cleveland the station has been moved from 2114 Superior viaduct to 1106 Walnut avenue.

The Iron Products Corp., La Crosse, Wis., will construct a new foundry. C. R. Pieper is general manager.

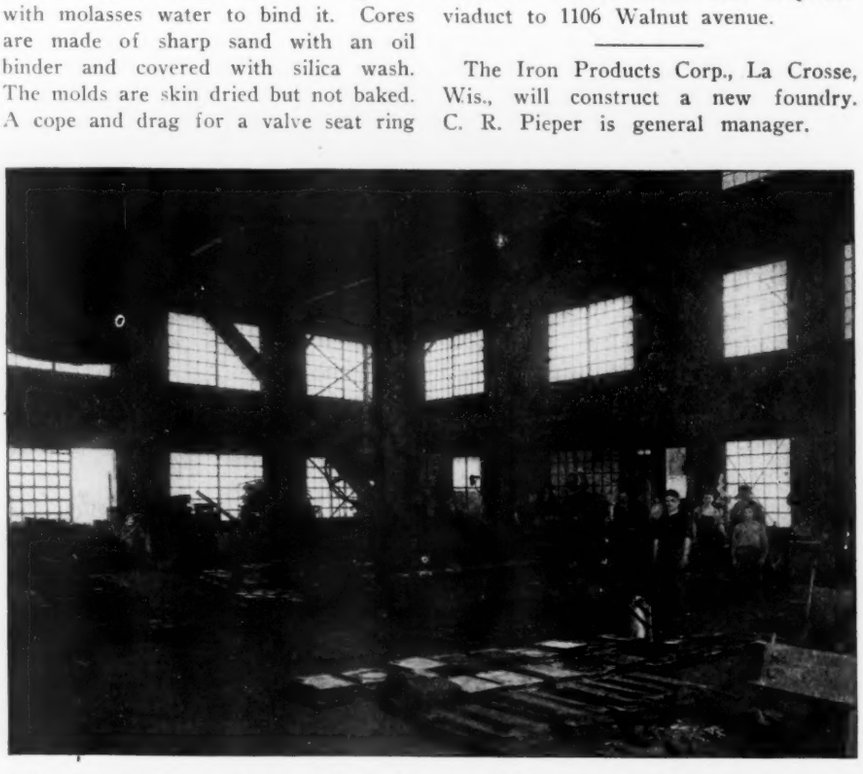


FIG. 6—THIS PORTION OF THE FOUNDRY SHOWS SOME FLOOR WORK—NOTE THE OIL BURNER IN THE FOREGROUND TO THE RIGHT—THIS IS USED TO SKIN DRY THE MOLDS

British Adopt Centrifugal Casting

Primary Conceptions of Casting in Rotating Molds, the Evolution and the Final Application of the Process to the Manufacture of Piston Rings Are Discussed—Rapid Stripping of Mold Essential

BY GWILYM WILLIAMS

ROTARY casting machines are those in which casting is assisted by centrifugal force. There are two main classes, those in which centrifugal force is applied horizontally, and those in which the force is expended vertically. The two may be simply illustrated. If a volume of liquid is placed in a cup-shaped receptacle, and the whole be revolved, the liquid will tend to press outward against the sides and leave the middle. The surface of the liquid takes a curved form, as shown in the upper drawings in Fig. 1. On the other hand, if the liquid be placed in a drum-like container, whose axis is horizontal, and the whole be revolved on this axis, the liquid will spread itself evenly over the inside of the drum and leave a cylindrical hollow in the midd'e, as shown in the lower illustrations, Fig. 1.

The machine illustrated in Fig. 2, from a patent application by J. Whitley in 1865 is an example of the first class of machine. This consists of a mold lined with a mixture of silicate and plumbago, revolved around a vertical axis, and was used for casting tires for railway wheels. The casting in this instance was allowed to remain in the mold to cool slowly. In effect, this machine consisted of little more than the making of an ordinary mold and revolving it during casting.

Presented by Gwilym Williams, technical engineer, Coventry, England, before the Coventry branch of the Institute of British Foundrymen.

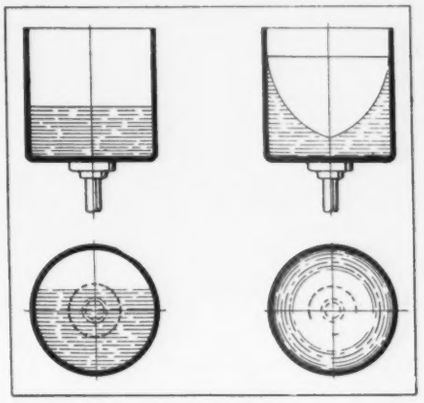


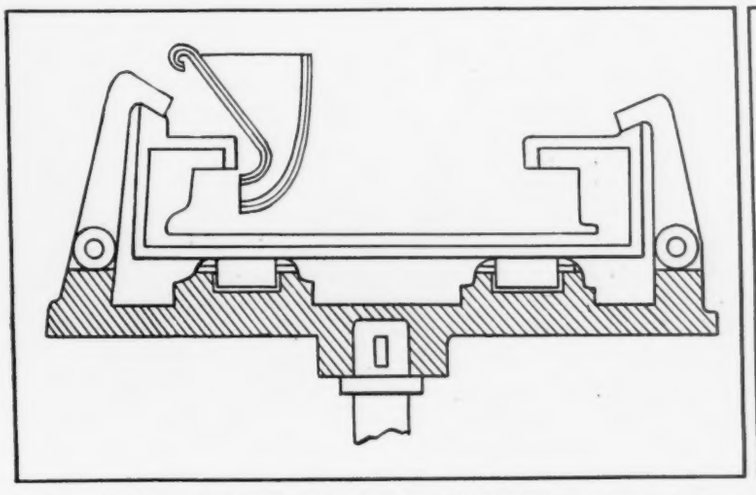
FIG. 1—ABOVE—EFFECT OF ROTATING A LIQUID IN A HORIZONTAL PLANE—BELOW—CENTRIFUGAL FORCE EXERTS THIS EFFECT UPON A LIQUID ROTATED IN A VERTICAL PLANE

An illustration of the second class of machine is afforded by a description in a patent specification by W. Thompson in 1873, used for casting lead sheets. This is shown in Fig. 3. Molten lead was poured into a cylinder revoving on rollers, and having flanges at the ends projecting inward. The metal was spread evenly over the surface on the cylinder by the action of centrifugal force, and when set the sheet was cut longitudinally with a knife and removed through the end. The molds in this case were made of metal, and the process was an example of permanent mold casting.

The first attempt to cast metal in rotating molds apparently dates back as far as 1809, 111 years ago. However, the most instructive idea of the method may be obtained from a series of patents taken out by Sampson Fox and Joseph Whitley over a period from 1879 to about 1885.

In one of the first patents taken out by the two inventors the cylindrical, horizontal, permanent mold is apparent, as usual, but the runner or pouring device has received special attention. The equipment shown in Fig. 4 consists of a bottom-pour ladle, mounted on wheels, with a trough or pipe perforated with a number of holes along the bottom extending into the mold to carry the flow of metal. Evidently the pouring trough or nozzle was designed in this way to insure that the mold received the metal from end to end, thus preventing cold laps, uneven thickness in the casting, and similar troubles. This machine was designed for casting steel and other plates for boilermaking, shipbuilding, and other purposes, such as tubes for internal fire boxes and flues.

The next step in the history of the process is seen in another patent taken out by the same men in 1884. In this process it is stated that a reciprocating motion is given to the fluid metal when flowing into the molds, and also the introduction of compressed air into the interior is claimed. It is evident that this patent claim, like the last, pays attention



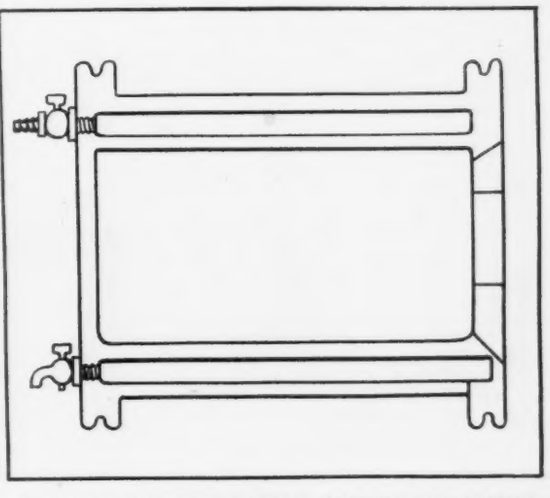
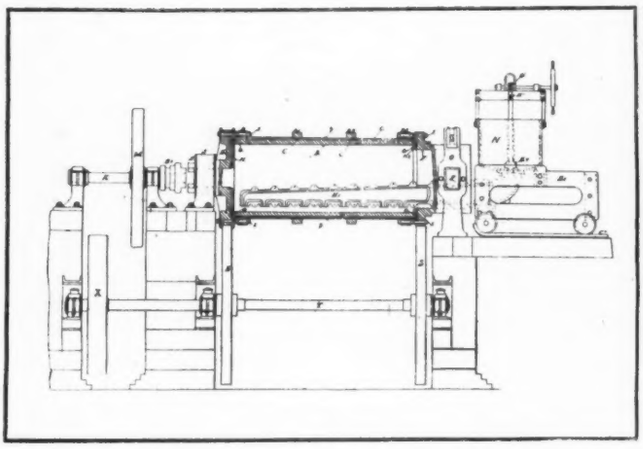


FIG. 2—MOLD FOR CAR-WHEEL TIRES UTILIZING HORIZONTAL ROTATION FIG. 3—AN EARLY TYPE OF CENTRIFUGAL MACHINE FOR MOLDING LEAD SHEETS DEMONSTRATES THE PRINCIPLE OF ROTATION IN A VERTICAL PLANE



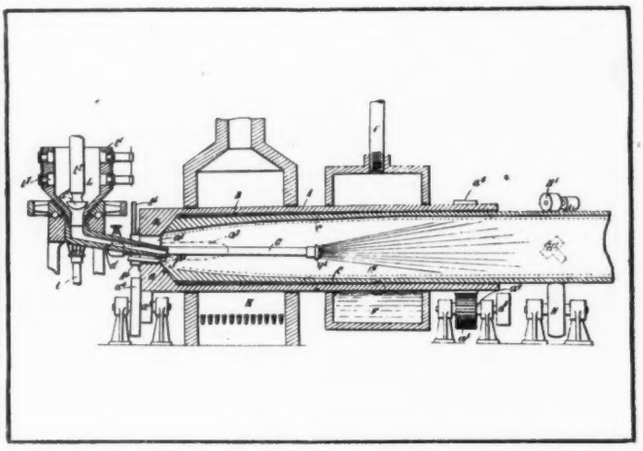


FIG. 4—ROTATING MOLD WITH DEVICE FOR FEEDING METAL UNIFORMLY TO PREVENT COLD-LAPS FIG. 5—MAXIM CONTINUOUS PIPE MAKING MACHINE BASED UPON PRINCIPLES OF CENTRIFUGAL FORCE

principally to the way in which the metal is caused to flow into the mold. In the language of the patentees—"the vacuum caused by the great heat in the respective molds causes a tendency to create not only drawn but blown holes." The idea of introducing compressed air was obviously to neutralize the vacuum they mention. They gave a reciprocating motion to the metal so that—to quote the patentees again—"plates, shells or sheets so made will be free from chill or wave lines, seeing that the metal is not suffered to fall on the same spot but receives while in its fluid state a motion like unto the webs of woven fabrics when passing over a folding or measuring machine, thereby interlocking as it were the whole of the molecular structure of the entire mass whatever its thickness may be and thus preventing the formation of those common centers of heat, the tendencies of which are to form partial porosity, by feeding the consolidating or the crystalizing of the total mass contained in castings so constructed."

The next step was in a patent taken out by J. Whitley, alone this time, and is perhaps a retrogressive rather than a progressive one. He proposed in this to use molds lined with asbestos, talc, or other heat resisting packing as differentiated from casting directly in a chill mold. The reason given for lining the mold with refractory material was that by this

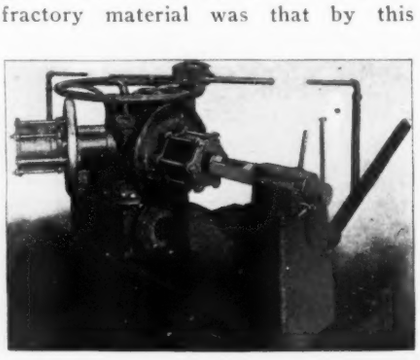
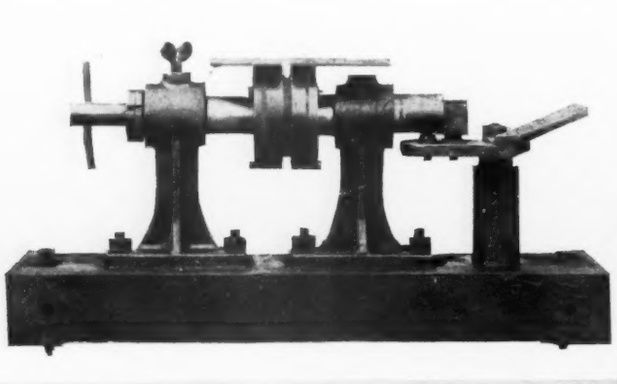


FIG. 6—CENTRIFUGAL MACHINE FOR CASTING PISTON RINGS INDIVIDUALLY

means the heat force in the liquid was materially reserved from external radiation and transmission, thereby creating a greater density and homogeneity in the molecules, and obtaining a greater tensile strength. It is evident that the last three patent claims form a history of troubles experienced, and an attempt at their solution. However, they do not show a correct appreciation of the source of the trouble, although the last specification by J. Whitley gives the remedy for the difficulty.

Two other ideas appearing among these two inventors' patents deserve mention. One is an attempt at weighing the metal before pouring it into the mold as a remedy for varying thicknesses of successive castings, and the other the mounting of the mold in a shell and the ejecting of the whole after casting through the action of a screw and bandwheel.

In addition to these interesting specifications, there are various isolated instances of the application of centrifugal force in other directions, one being described in a patent taken out by Sir Hiram Stevens Maxim and Hudson Maxim in 1895. This invention, shown in Fig. 5, was conceived to make pipes in continuous lengths by the rotary process. The inventors claim the making of pipes of various substances such as iron and steel, lead, glass and other fusible substances, together with pipes made of two substances, such as glass lined or enamelled tubes. The method proposed was to feed the metal into one end of a rotating mold which was tapered toward the feeding end so that the liquid metal as it was introduced



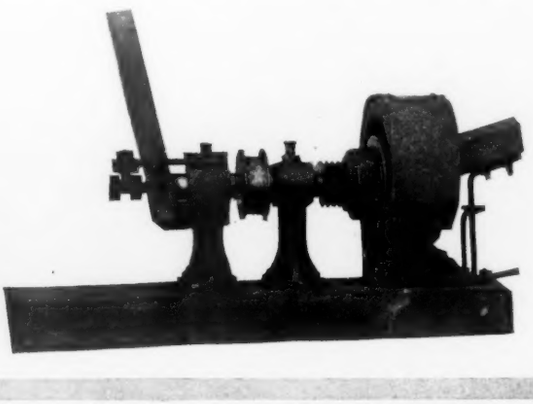


FIG. 7—AN EARLY TYPE OF BRITISH PISTON RING MACHINE WITH PERMANENT MOLD AND CORE FIG. 8—ONE OF THE FIRST EJECTOR-TYPE ROTATING PISTON RING MACHINES

pushed out the partly solidified metal in front of it. The further end of the mold was cooled by a water jacket, and the solidified pipe received and conducted from the end by tangential rollers. There also is mentioned in this patent a means for introducing into the interior of the mold a neutral or reducing gas to prevent oxidation. The introduction of such a gas is significant, as will be seen below.

Another patent taken out in 1917 relates to making wheels whose tires are of different material from the body. For instance, in the case of car wheels the tires may be made of manganese steel and the body or hub of the usual mild steel.

American Machine Cited

A rotary casting machine which is at present being used in the United States was described in the *American Machinist* of Jan. 11, 1919. This machine, shown in Fig. 6, is used for casting piston rings as individual castings, a number at a time. It consists of a standard to which four molds can be attached, and around which they may be revolved horizontally so that each in succession comes opposite to the pouring spout. The molds are made up of a series of disks or plates clasped together so that the spaces between form molds for the piston rings. After casting, the whole mold is transferred to a machine which disassembles it and removes the rings. The action is continuous, for no sooner is a cast mold removed than another, already assembled, is swung into place ready for casting. The rings which are produced are chilled, in spite of a high percentage of silicon, because the size of the casting is so small in comparison with the size of the mold. They must be annealed before machining.

The rotary casting machines used at the British Piston Ring Co., Ltd., Coventry, England, for casting piston ring pots were patented by William A. Oubridge, of that firm. Another machine for casting fuses, pistons and other small articles of irregular shape, was patented by Mr. Oubridge, another gentleman and the author. The design of both machines centers entirely around the rapid stripping of the mold from the casting when it is made.

In the piston ring pot machines, Fig. 9, the end plate is not bolted onto the mold in any way, but is held by an independent bearing, or its mechanical equivalent, tight up to the body of the mold. A plunger operates on the opposite end of the casting when it is made allowing only a slight movement for clearance, so that when the rack and pinion comes into operation drawing back the mold, the casting falls out. In the other machine the molds or dies are arranged around a central chamber, from which the metal flows into them by short runners. The molds are split vertically, one half being held by an independent bearing, and the other half attached in series with the rack and pinion, for easy stripping. The plunger again is apparent, and a device operates for the removal of cores by centrifugal force.

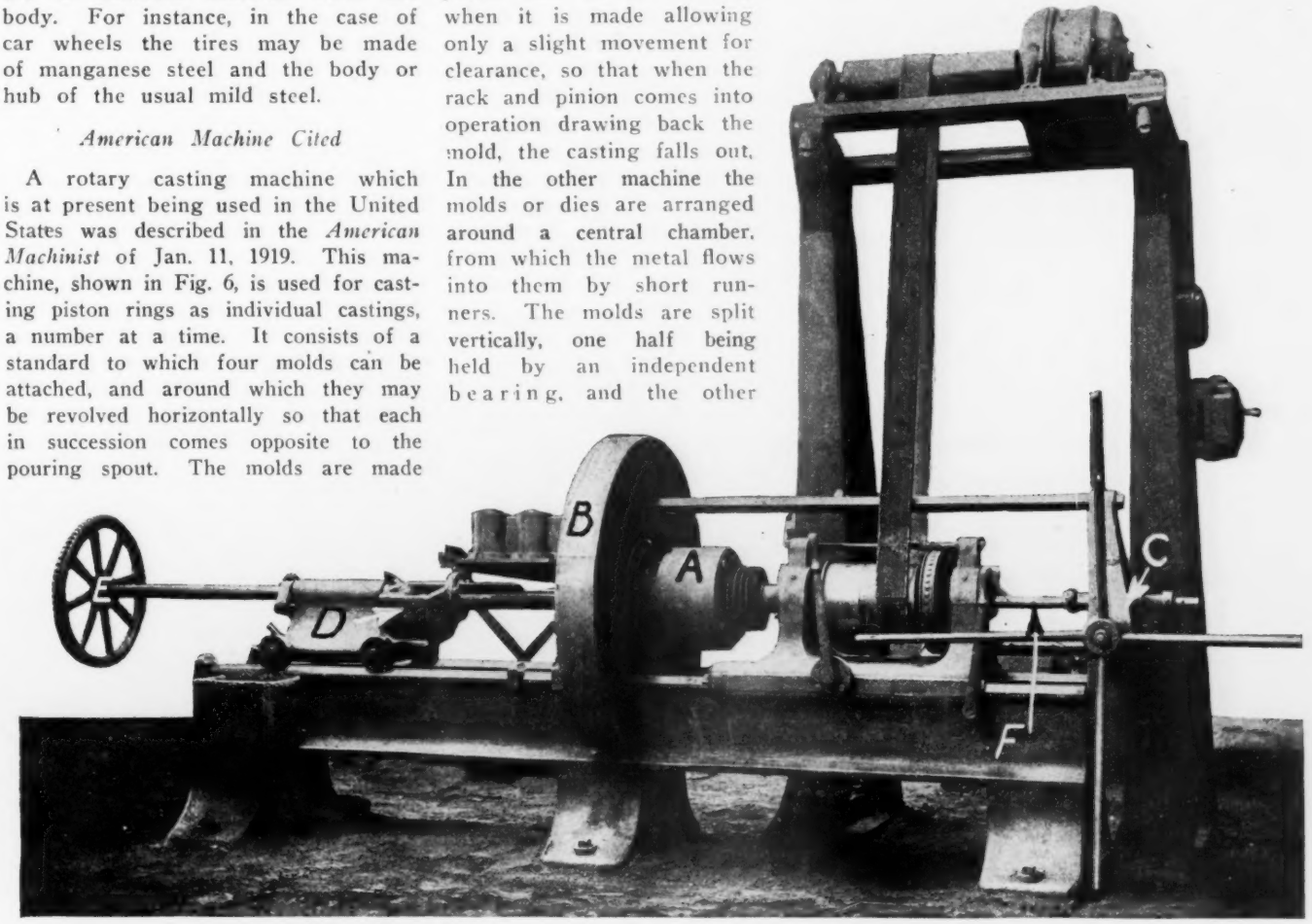


FIG. 9—MODERN BRITISH PISTON RING MACHINE WHICH MAKES AND EJECTS THE POTS FROM A ROTATING PERMANENT MOLD

Another firm employing rotary casting machines successfully in England is Messrs. Stokes Castings, Ltd., Mansfield, the machines which they use being patented by F. W. Stokes.

Early Experiments Reviewed

The first experiments which were made at the British Piston Ring Co., Ltd., involved the stationary casting of single rings on a small machine one at a time. This machine, shown in Fig. 7, does not rotate the mold. The core as well as the mold were made of iron. It was this little machine that taught the experimenters the importance of the rapid removal of the casting, for every one of the rings was split or broken until a means for opening the mold quickly was adopted. To get a complete ring, the machine had to be opened in less than two seconds after casting, before the operator hardly had time to move away.

The second little machine was a rotary type, and the same means for rapid ejection were incorporated in it. This is shown in Fig. 8. The casting of pots was but a short step to take, since a piston ring pot is nothing more than a long or wide ring.

The actual operation of casting on the machine may be described with the aid of Fig. 9. First the mold inside the shell *A* is brought up tightly against the end plate by the operation of the capstan handles, *C*. It is held by the independent bearing, hidden in the figure behind the guard *B*. The mold is then rotated. Molten metal is brought to the ladle *D*, the spout of which is pushed into the mold through the end bearing, and by tilting the handwheel *E* the metal flows into the mold. In a few moments the casting is set. The rotation of the mold is stopped, and the handles *C* are operated to strip the mold from the casting. The plunger

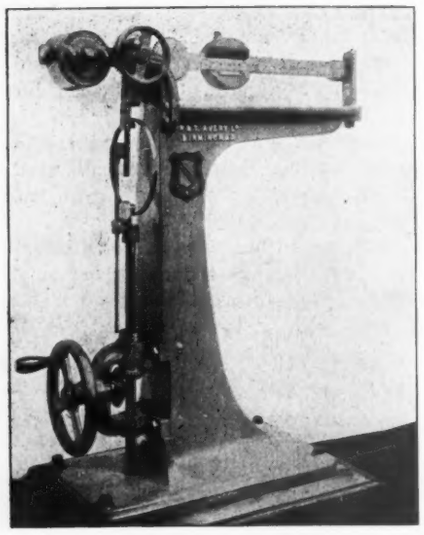


FIG. 10—TESTING MACHINE FOR DETERMINING TENSILE STRENGTH FROM THE RING DIRECT

which is situated at the front end of the rod *F*, remains nearly stationary, and serves to eject the casting in its red-hot state, as the mold is withdrawn. The operation takes far longer to describe than to perform. In practice a few minutes serve to convert molten metal into finished castings.

There is no necessity to weigh, or otherwise measure, the amount of metal that is put in the ladle. All that is done is to make the hole in the end plate of the same size as the required bore of the finished casting, and allow any excess metal to overflow into the guard. If care is taken to see that no excessive variations of temperature occur on successive ladles of metal, no variation will be found in the thickness of the castings. Of course it is possible to have short runs, but if the operators watches the sparks he cannot help knowing when the overflowing of the metal takes place.

Piston Ring Iron Defined

Before describing the difficulties and limitations of the rotary casting method, it is necessary to consider what is meant by piston ring iron, because it was for the production of piston ring pots that the machine illustrated in Fig. 9 was designed. The iron from which piston rings are made has to be of special quality both as regards tensile strength and elasticity, that is, nonliability to permanent set. It must be close grained and hard enough to resist wear to which a piston ring is subjected. These qualities only can be attained when the iron contains about 0.8 per cent combined carbon; that is, when it is as near as possible to being chilled without actually going over the line.

In the same specification is included a tensile test for actual rings that the author originated. The ring it is desired to test is measured, split or fractured, and then broken by being pulled apart on a small tensile testing machine similar to that shown in Fig. 10. Then from the weight at which the ring breaks, the tensile strength of the material in tons per square inch may be calculated by a formula. This method is useful, as it eliminates the necessity for relying on test bars which may or may not represent the castings for which they are intended. It also allows any ring to be picked up in the machine shop and tested immediately. Any casting from which a ring may be machined for example, a piston casting, may be tested in the same way.

A further test for permanent set, or "elasticity" is being considered by the aircraft subcommittee. This is apparently the first time that this property of cast iron has been commercially tested. In fact there are few classes of work in cast iron where this property needs testing. To produce iron rigorously to specification to pass these severe tests is the crux of the whole

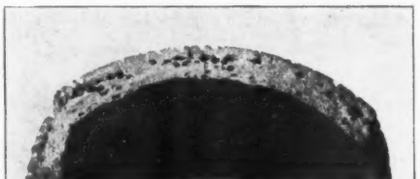


FIG. 11—PINHOLES ARE THE GREAT OBSTACLE TO HOT-MOLD CASTING

piston ring material problem just now.

It is necessary that any rotary casting method to be applicable to piston ring pots must be susceptible to control as regards the properties of the casting. The controlling combined carbon must be fairly easy. Experience shows that this essential is attained when the molds are worked *as hot as possible*. Of course, the castings must be ejected from the machine with mathematical regularity, immediately after they are set.

Some users of the rotary method usually work the molds from the opposite point of view, as cold as possible. In the "Founders' Manual" a record of permanent mold casting carried out by Edgar A. Custer, in the United States, is given. Without giving definite information as to sizes of molds in relation to sizes of castings, Mr. Custer impresses the necessity for great mass. For example, a mold for a 2-inch soil pipe T weighs 500 pounds, one for a 3-inch trap 1700 pounds, and in a mold for a 4-inch soil pipe weighing 65 pounds 6500 pounds of iron is specified. Castings were made in this mold every seven minutes without raising the temperature over 300 degrees Fahr. Mr. Custer states that the molds improve by continual use and at the time of giving his paper before the American Foundrymen's association he had one in which 6000 castings had been made. He also emphasizes the necessity for removing the castings immediately after they are set.

The molds used at the British Piston Ring Co., Ltd., in comparison with Mr. Custer's are flimsy, for the thickest at present on the machine is 1¼ inches. The molds in the first experiments were little more than ½-inch thick, the reason being that it was desired to cast with the molds as hot as possible.

Same Laws Apply

The laws which connect silicon percentage, rate of cooling and combined carbon, operate in the case of permanent mold casting as in the case of sand casting. That is to say, whether casting in sand or in a permanent mold, the quicker rate of cooling, other things being equal, the higher must be the percentage of silicon in the metal to produce a given percentage of combined carbon. Thus, generally speaking, since permanent molds cause a much more rapid cooling than sand, the silicon percentage in the metal cast in the chill mold must be higher than in that cast in sand, to obtain the same result. Sometimes the rate of cooling of the permanent mold is so great that the castings will persist in chilling, unaffected by a high percentage of silicon. This is the case with the American machine for casting individual piston rings, for the softening influence of silicon ceases at about 4 per cent.

One of the troubles of casting in cold molds is the chilling of ends or parts of the casting which are subject to the most rapid radiation of heat. The remedy consists in designing the mold in such a way that at the particular points where chill is expected, the heat is most conserved. This can be done by making that part of the mold thin, or by covering it with layers of nonconducting material. One of the reasons why the molds in the machine illustrated in Fig. 9 are attached to

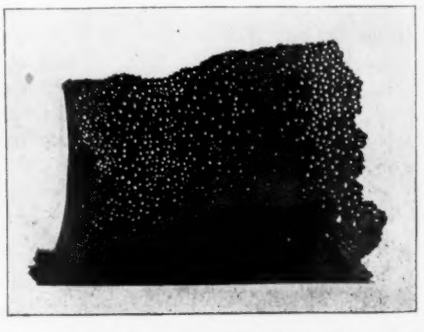


FIG. 12—RESULTS OF OXIDATION FROM THE MOLD SURFACE

their shell by means of a flange round their middle, is that by so doing the heat is more conserved on the ends In other words, the part of the mold which is most liable to overheat is the middle, so to equalize cooling the molds are attached to their shell by their middle.

Molds Short Lived

The life of the molds in comparison with Mr. Custer's large output per mold, is short. This is because of the drastic treatment they receive. The author generally is content if 300 castings per mold are obtained, for even with this quantity the cost of the mold spread over the castings obtained from it is a small item.

The reason for the deterioration of the molds is annealing and penetrative oxidation due to repeated heating, and cooling. This annealing is accompanied by growth. However, this is not serious provided all parts of the mold receive the same treatment. If the back end of the mold is persistently hotter than the front end, trouble eventually will ensue in ejecting the castings from the mold, for the rear end of the casting will be larger than the aperture through which it has to be forced. This forms another reason why the molds are attached to their shell by their middle in the above machine.

The bugbear of casting in hot molds is pinholes similar to those shown in Fig. 11. They take the form of little cavities in the casting caused by gases trapped in trying to find an escape through the molten metal when it is poured. This is the trouble which Sampson Fox and Joseph Whitley evidently experienced. The author has found that there apparently are two sources of these gases, one being the air that is trapped in the interstices of the inside surfaces of the mold and the other source being a chemical one, namely, the decomposition of the oxides lining the interior of the mold. The trapping

FIG. 13—DISTRIBUTION OF GRAPHITE IN SAND CAST SPECIMEN—MAGNIFIED 100 DIAMETERS

of gases in the minute depressions of the surface of the mold can be overcome by paying attention to the method of pouring. The iron must be run in such a way that this air is swept before the metal from one end of the mold to the other. The way the author found the best method of pouring was by experimenting with aluminum pots, as that metal does not cause the chemical decomposition of the oxides lining the interior of the mold.

The other source of trapped gases results when casting iron. The carbon in the iron, when it comes into contact with the oxides lining the mold, decomposes them with the formation of carbon monoxide and dioxide in proportions according to the temperature. That this actually happens was borne out from observation of specimens under microscope which showed apparent

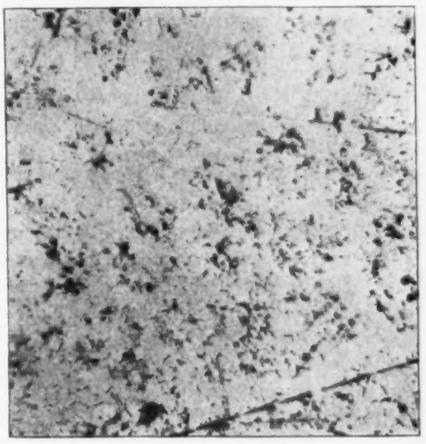


FIG. 14—GRAPHITE IN ROTARY, PERMANENT-MOLD CAST IRON—MAGNIFIED 100 DIAMETERS

decarburization at the edges of the pinholes. The main body of the casting was made up of a pearlitic matrix, whereas tracts of ferrite could be seen round the holes. Further, to test this theory, an experiment was carried out to determine what would happen when the iron came into contact with an oxide artificially introduced into the mold. First, all traces of plumbago were removed from a mold, and red lead, being an oxide easily reduced by carbon, was introduced. Molten metal was poured into the machine, and the result was a stuck casting. Persuasion failed entirely to eject the casting, so it had to be turned out in a lathe. Part of the shell that remained is shown in Fig. 12.

Subsequent examination of the inside surface of the mold showed also small bright globules which were evidently metallic lead, reduced from the oxide. No doubt these were the cause of the sticking.

The second source of pinholes being fairly well established, it remains to consider the remedy. Obviously, if the

FIG. 15—DIFFERENCE IN STRUCTURE IS NOTED BETWEEN STILL-CAST AND CENTRIFUGALLY-CAST IRON—THE UPPER SPECIMEN WAS CAST IN A ROTATING MOLD

carbon in the molten iron could be prevented from coming into intimate contact with the oxidized surface of the mold, or on the other hand the surface of the mold could be prevented from becoming oxidized, the remedy is found.

Consequently, with the latter idea in mind, molds made of materials less liable to oxidation than cast iron, were tried. Two or three such molds were made of a steel which is used with success for hardening boxes, due to its resistance to oxidation. The use of this material for the molds reduced the scrap caused by pinholes by more than half; but unfortunately, the gain was not proportionate to the cost. After experiments in several directions, it was decided that the solution of the problem by finding a nonoxidizing mold material was impracticable. It may be possible in laboratory experiments to have molds made of nickel, or other still more expensive metals which do not oxide easily, and obtain success with them, but many practical difficulties arise which put such molds entirely out of question commercially.

Deoxidizing Gas Impractical

In Sir Hiram Maxim's specification is mentioned the introduction of neutral or reducing gases into the mold for preventing oxidation. The idea is feasible with such a continuous mold as his was; but where the mold has to be continually opened in order to eject the casting, it is difficult to see how the oxygen of the air can be prevented from getting to the mold.

The alternative is to prevent the molten iron from coming into contact with the oxides of the mold, by having the mold lined with some thin coating of refractory material, as suggested by J. Whitley in one of his later specifications. Such a lining might take the form of a thin coating of loam, or fireclay shells could be used, being placed in the mold just previous to casting, and ejected with the casting. Thin sheets or shells of steel might answer the same purpose. The Ford Motor Co. in America produces a large quantity of piston ring pots by the rotary method, and it is believed that it is

their intention to try carbon shells. The author used plumbago of good quality for the purpose, care being taken that the plumbago is distributed as evenly as possible over the entire surface of the mold. Plumbago, however, is not a certain remedy for the trouble.

There is a critical temperature, below which the dissociation of the iron oxide does not occur, and if the character of the work is such that the temperature of the mold can be kept below this point, the pinholes will not appear. Such is the case with Mr. Custer and with the American machine for producing piston rings individually. In the latter case the castings are chilled, so that it does not matter how cold the molds become.

Not only do rotary castings as a whole show superiority over sand castings on production, but they also are superior in physical properties. The distribution of the graphite in rotary castings, examined under microscope, is shown in Fig. 4. It will be seen that the large flakes usually seen in sand castings are absent, the graphite in the rotary casting being more in the form of nodules resembling the temper carbon in malleable castings. This distribution of garphite materially helps in giving to the iron a good tensile strength as well as a elasticity. Since the size of the graphite particles determines to a great extent the closeness of grain, when viewed by the eye, rotary castings are much superior in this respect. This is indicated in Fig. 15 and also goes to show that the cause of the closeness of grain and the small size of the graphite particles, in the author's opinion, is nothing more than rapid cooling. The effect of the centrifugal method, or the pressure due to it is negligible. In corroboration of this the following may be added. The pressure of the molten iron against the surface of the mold can be determined by the following formula:—

If F = centrifugal pressure on mold in pounds per square inch,
N = revolutions of mold per minute,
D = diameter of casting in inches,
t = thickness of casting in inches,
Then

$$F = 0.00045tDN^2.$$

It may be seen from the formula that the pressure is proportional to the thickness of the layer of molten metal that makes the casting. That is, the layer that is most subjected to pressure is that next to the mold, and the layer that is least subjected to pressure is that on the extreme inside. Assuming the mold to be revolved at a speed giving a pressure of 60 pounds on the surface of the mold, the pressure half way through the layer of molten metal will be 151 pounds and on the extreme inside layer of molten metal the pressure will be nothing. Hence, if pressure had anything to do with the closeness of grain, it would be expected that the layers of the casting next the mold would be much closer grained than those farthest from the mold. This is not true, for no difference can be observed, with the highest power microscope, between the inside and outside of a piston ring pot casting. Moreover, it is possible artificially to produce a casting that is more open grained at that part which is subjected to most pressure, and closer grained at that part which is subjected to least pressure. This can be done by rapidly cooling the interior of the molten metal by a stream of compressed air. It follows that the rate of cooling of the casting has far greater influence on closeness of grain than pressure has.

The advantage of grain closeness, and tensile strength and elasticity that usually go with closeness of grain, therefore, is not confined to rotary casting, but should be a feature of all permanent mold casting. Where rotary casting scores over ordinary permanent mold casting is in the speed of production which is greater for the former. The molds can be made simply, and there is no trouble with complicated gates and runners.

With the rotary method, dirty castings are entirely eliminated. This is due to the centrifugal action having a tendency to throw all the lighter constituents to the inside, so that all slag and rubbish which may be present in the metal is flushed out, and overflows into the guard of the machine. The only cause of scrap that is excusable in rotary casting is the pinholes due to the decomposition of the oxides of the mold. There is no reason whatever when casting nonferrous metals that a single scrap casting should be made.

Problems of the Foundry Discussed

RICHARD MOLDENKE in his talk before the February meeting of the New England Foundrymen's association emphasized the fact that the foundryman wants service and not theory. The best way for a foundryman to solve his problems is to know what cast iron really is. Cast iron or gray iron, Dr. Moldenke explained, may be considered as steel plus graphite. When looked at from this point of view, it will be seen that all of the things ordinarily affecting steel also affect cast iron and when the iron part of gray iron, that is the metal, independent of graphite, is considered, its composition and characteristics agree closely with those of steel.

Dr. Moldenke stated that there are three principal problems before the foundry metallurgists of today. The first of these problems is important because of the increasing amount of sulphur occurring in scrap and the fact that large bodies of ore containing sulphur are not being used, on account of the general impression that this element is detrimental to castings. Dr. Moldenke is inclined to doubt the sweeping assertion that sulphur is a harmful factor in gray iron. In some cases, sulphur is an advantage as, for instance, in brake shoes. The best wearing shoes contain a high percentage of sulphur. It is true that too high a percentage makes the shoes brittle but the braking and wearing qualities apparently increase with the sulphur content. The explanation of this is that the sulphur tends to form a coating around minute particles which in effect makes the metal granular so that the wearing service instead of shredding, as is the case with steel, wears down by the peeling off or rubbing away of minute particles. The average sulphur content found in scrap is 0.12 per cent but the exact effect of even small quantities of sulphur is not definitely known.

The second problem is that of overcoming the difficulty at present experienced with facing sands. The action of molten metal will streak and erode the graphite wash now frequently used for facing molds, and no completely satisfactory wash has yet been found.

The third problem includes that of getting the iron into the molds and has to deal with shrinkage, uneven cooling and the many phases incident to castings containing a combination of light and heavy parts.

The speaker referred to a recent editorial in THE FOUNDRY concerning the piling of pig iron so as to separate the different grades of silicon. This he thought was an excellent idea, but he would go a step further and also separate the different brands of iron. The brand, he said, has an important bearing upon results, which should not be overlooked in the better grade of work. The question of foundry scrap was covered at some length. The principal points considered in this subject were the composition of the scrap and the care necessary in charging, especially

when using steel scrap. The charge should be made so that the steel scrap, iron scrap and pig, will all melt as near at the same time as possible. Some idea of the composition of scrap is often obtained from its appearance. Scrap which is not machined is apt to be low in silicon and inferior in quality. Grate bars are always detrimental in scrap, because they are so often burned and then become practically useless. In figuring the price of scrap the loss during melting should always be considered. Tests have shown this loss for pig iron to be approximately 1 per cent; for machinery scrap 2 to 3 per cent; stove plate 4 to 5 per cent, and grate bars 8 to 15 per cent and higher. In briquetted scrap the loss occurring varies according to the density but is usually as high, if not higher, than scrap metal.

Correcting Flaws in Metals and Mixes

Problems of the Gray-iron, Malleable and Steel Foundry Discussed

By H. E. Diller

Several Steel Alloys Made With Chromium

Question.—We would like to have complete information in regard to the manufacture and use of chrome steel for castings.

Answer.—Chrome steel is made by adding ferrochrome to the bath of molten metal in the open-hearth or electric furnace, after the metal has been killed and is deoxidized. The ferrochrome which is used is put under the slag so as not to be unduly oxidized by contact with it. Being heavier than steel the alloy tends to settle to the bottom and the bath must be rabbled to increase the rapidity with which the ferrochrome is absorbed by the steel. It is claimed that the oxidation of chromium is greater in the open hearth than in the electric furnace.

There are two general classes of chrome steel castings. In the one, chromium is the only alloy, other than the regular amount of manganese, that is added to the steel. In the other, chromium is added in conjunction with some other metal. Where chromium alone is added to the steel the purpose is to secure a very hard steel. The composition of the finished metal will include approximately 1.25 per cent chromium with 1.10 per cent carbon. This steel is used where high wearing qualities are desired.

Two alloys are formed by adding both chromium and nickel to the steel. Both of these alloys usually contain 0.30 to 0.40 per cent carbon, but differ in that the one contains more chromium and nickel than the other. The lower alloy is made with approximately 0.80 per cent chromium and 1.50 per cent nickel. The other will contain about 1.50 per cent chromium and 3.50 per cent nickel. This steel is more difficult to make than the one with the less amount of alloy and has little advantage over it in the way of physical properties.

Chromium also is used to make a chrome vanadium steel. The usual alloy contains 1.00 per cent chromium and 0.15 per cent vanadium. The carbon in this steel is the same as in the chrome nickel steel or a little higher, but not over 0.50 per cent. Special experience is required to enable the melter to make this steel without oxidizing an excessive amount of vanadium.

The main advantage in alloy steels is obtained from heat treatment which greatly increases the strength and ductility of the metal. This is utilized to the fullest extent in rolled and forged sections, but has not been so fully developed for castings. This is probably due to the intricate design of the majority of castings which makes it difficult in many cases, and impossible in others, to quench the castings from high temperatures without cracking them. However, a number of foundries have started to heat treat castings. Some of the simpler designs are quenched and drawn, castings from more complicated patterns are air cooled and then drawn slightly. The most intricate castings are only annealed.

Shrinkage Difficulties

Question—We are having trouble with shrinkage at the intersection of the barrel core with the bottom of the water jacket on a 6-cylinder gasoline engine. Chills help to eliminate some of the shrinkage but not all of it. Please tell us what to do to overcome the difficulty.

Answer—You should use an iron with low phosphorus, say about 0.250 per cent. The silicon should range around 2 per cent and the sulphur be kept below 0.10 per cent. Manganese may vary from 0.50 to 0.90 per cent. If there is any way the design of the cylinder could be changed so that the thin sections merge more gradually into the heavier sections it would be a benefit.

Common Causes for Defective Castings

Question.—I am sending you three pieces of iron broken from castings which showed spongy spots. Two of these pieces were taken from cylinders and one was taken from a fly wheel. The fly wheel hub has three bosses cast in the cope side and the shrinkage occurs at these spots. The jobs will run along for weeks without loss from shrinkage and then we begin to lose castings from shrinkage defects, although the same kind of iron is used in the cupola charges. The composition of the iron in the castings is: silicon, 2.50 per cent; sulphur, 0.80 per cent; phosphorus, 0.60 per cent; manganese, 0.50 per cent; graphitic carbon, 3.40 per cent; combined carbon, none. We would ask why our chemist reports no combined carbon and whether the iron would be hard to run if we reduce the amount of phosphorus.

Answer.—It is clear that the hole in the piece from the cylinder which was sent was caused by gas, while the porous spot in the other piece was due to shrinkage. A gas hole could be caused by moisture in the mold or by too hard ramming. It might also be produced if the iron contained too much sulphur or had been severely oxidized in the cupola. The shrinkage may be due to the design of the casting, the composition of the metal, which might include oxidization, or to pouring a heavy section too hot.

The piece which you sent that did not have any imperfections showed a markedly different grain of metal than the other two pieces. This would indicate that your iron is not regular. We would suggest that you take drillings from a piece which shows shrinkage and from one which appears to be solid, and have them analyzed to see whether there is a variation in the metal. There are a few changes which should be made in

the composition of the metal you are using. The amount of silicon is too high and should be lowered to between 1.75 and 2.00 per cent. The phosphorus is also too high, and should be kept around 0.20 per cent, certainly not higher than 0.4 per cent. You will have no trouble to get such a metal hot enough to run cylinders if it is melted properly.

We cannot understand how you could get a cast iron without any combined carbon, although in large sections there might be only a trace of combined carbon which your chemist might report as none. If the sample was taken from the cylinder it is practically impossible that there was no combined carbon in the iron; but the section of the fly wheel is somewhat larger and it might be possible that there was only a small amount of combined carbon at the point where the sample was taken.

Ferrosilicon Scrap Mixture

Question—We are melting a good quality of scrap without any pig iron and not using any flux. We use a coke high in sulphur and add 1 to 2 per cent silicon in the ladle. Our iron comes out too hard to machine well and contains blow holes.

Answer—The holes probably are due to too high sulphur in the iron. This could be reduced by using a lower sulphur coke. The effect of the sulphur also can be neutralized by adding manganese to the ladle in the form of pea-sized 80 per cent ferromanganese. About 6 or 8 pounds of this could be profitably added to a ton of metal. The metal then should be left stand in the ladle a few minutes to give the manganese sulphide, which would be formed by the addition of the ferromanganese, time to rise to the top of the metal. It can then be skimmed off with the slag.

We would advise against putting 1 or 2 per cent silicon in the ladle to try to make it mix with the iron unless it is added in the molten state. Ferrosilicon is lighter than iron and tends to rise to the top of the metal when added in the solid conditions. For this reason it is difficult to mix a great amount of silicon with the iron by adding it in the ladle. The silicon should be added to the charge in the cupola in the form of ferrosilicon in which the silicon ranges anywhere from 10 to 15 per cent. If enough of this is added to bring the silicon content of the iron up to 2 per cent, and the ferromanganese is added in the ladle you should not have any trouble with hard iron under proper melting conditions.

Overcoming Shrinkage In Cut Gear Castings

Question:—Please tell me what causes pin holes and shrink holes in cut-gear castings, 20 inches in diameter with a 2-inch face. I use a mixture of half pig iron and half machinery scrap. The pig contains 3.13 per cent silicon, 0.019 per cent sulphur, 0.560 per cent phosphorus and 0.60 per cent manganese. I use skim gates on all molds and on some I use basins also.

Answer:—The information which you give is not sufficient to enable us to give a definite answer to your question. Pin holes may be caused either by oxidized metal or by wet sand in the molds. The shrinkage may be due to the way the casting is poured and fed, to an incorrect design of the casting or to the composition of the metal being wrong.

To overcome the pinholes we would suggest you take precautions to see that the iron is not oxidized in melting, and the molds do not have any wet spots. Should you have oxidized or high-sulphur iron the addition in the ladle of 6 to 8 pounds of 80 per cent ferromanganese would be a benefit. In order to get away from the shrinkage you might try a mixture of 30 per cent No. 1 pig iron, such as you mention in your question, and 70 per cent machinery scrap. A better remedy, however, would be to get a low-phosphorus pig iron, either malleable or bessemer grade, and use not more than 70 per cent of this with the remainder of the mixture made up of low-phosphorus scrap iron. The phosphorus in your casting should not run over 0.250 per cent and the silicon should range between 1.75 and 2 per cent.

Making Castings to Meet Specifications

Question;—We have received an order for castings to be made to specications which require a tensile test and a percussion test. The specifications also require that the castings be made exclusively from iron which has been melted twice. To make these castings we have some No. 1 pig iron with 3.20 per cent silicon and a stock of engine scrap of good grade. We can obtain any grade of scrap and possibly some No. 2 pig iron.

Please tell us how to mix this iron so as to get a strong metal. We do not wish to have a mixture which will require chemical analyses as the work will not warrant the expense.

Answer:—The requirement that castings must be made from iron which has been melted twice is somewhat unusual. It means that you must melt your pig iron and run it into pig beds and that no new pig iron may be used in your mixture. Under these conditions, and not knowing the tensile strength required, we would recommend that you use a mixture consisting of 60 per cent remelted No. 1 pig iron and 40 per cent old engine scrap, or scrap from this mixture. Should this metal not be strong enough, a stronger iron could be made by taking a charge made up of 50 per cent remelted No. 1 iron, 40 per cent old engine scrap and 10 per cent steel scrap. You can get a strong metal without using remelted pig iron in the mixture and if this is not required do not melt the pig iron before putting it in the mixture. In such case use 10 per cent less No. 1 pig iron and increase the engine scrap by 10 per cent.

Melting Cast Iron Borings

Question—Please tell us how we can use our cast-iron borings in the cupola and still prevent excessive oxidation.

Answer—Cast-iron borings may be melted in the cupola in several ways. One method is to pack them into cans, and another similar way is to put the borings in lengths of stove pipe and close both ends by bending over the ends of the pipe. In both cases the smaller the container the more the borings will be fused together before the container is melted, and consequently less oxidation of the borings will take place. The containers should be placed in the center of the cupola on each charge.

Another way of handling the borings is to briquet them, but to do this would require an expensive machine and would not be economical unless a number of foundries joined together in order to keep the press busy a large proportion of its time, and so lower the investment charges. One foundry which has had its borings briquetted is planning to install a small electric furnace to melt the borings, although they will have only about one ton of borings a day to handle.

Metal With Low Coefficient of Expansion

Question—Please tell us the composition of a metal which has zero or minimum coefficient of expansion and which would be suitable for making pistons and valves for a die casting machine using babbitt metal.

Answer—A metal composed of 36 per cent nickel and the remainder iron will have practically no coefficient of expansion up to 400 degrees Cent. Care should be taken in making this alloy to see that the carbon content is kept down as low as it is possible to get it.

Steel Foundry Starts Operations—II

Height of Annealing Furnaces Is Adjusted by Lowering or Building Up the Side Wall on Which the Covers Rest — All Oil Accurately Metered After Passing Through Strainers

THE same care and attention to detail which characterizes the operations described in the previous article, has been used in designing the annealing furnaces at the steel foundry of the Vulcan Iron Works, Wilkes-Barre, Pa. Two of these furnaces have been provided by the company, the one considerably larger than the other. The larger furnace seldom is used but at times it is essential as occasionally castings are made which are too large to go into the smaller furnace. Both ovens are so designed that the height of the roof may be changed to accommodate the size of the charge as shown in the layout of the pits in Fig. 3. This is accomplished by building up the side walls, on which the top covers rest, with brick. The smaller furnace covered with the bungs at the lower level is shown in Fig. 7. When the walls are low a special bung, *G*, Fig. 3, is used to connect a bung at the normal level at each end with the bungs at the depressed level. By this arrangement a reduction of 720 cubic feet is made in the furnace space to be heated. The change is not made frequently, as usually, the lower arch is sufficiently high. The bungs are handled by a crane.

The furnaces are fired from both ends with soft coal. Like the drying ovens they are arranged so that either half of the heating chamber may be used alone. Thus either half may be fired and has a flue for the escape of gases. The covers are lifted off by crane and have been designed so that they may be piled on top of each other as shown in Fig. 4. The top covers also may be stored on top of each other on the furnace as illustrated in sections *A—A* and *B—B*, Fig. 3. This arrangement conserves a large amount of floor space which would be required were it necessary to place each bung upon the floor. A manhole, as shown in the elevation of section *B—B*, gives access to the flue for cleaning and repairing.

Castings are heated to 1650 degrees Fahr. for annealing. Care is taken to make certain that all castings in an anneal are heated through and the cooling is retarded. In case of some of the heavier castings nearly a week elapses from the time the castings are placed in the furnace until they are removed. A description of the pyrometric control of the furnaces will be given later in this article.

Steel is made in a 20-ton acid open-hearth furnace designed by the Wellman-Seaver-Morgan Co., Cleveland. This furnace is built on an elevated platform. The checker work which has been calculated to have 90 square feet of radiation surface per ton of metal is above ground. It is considered that this proportion of radiating surface in

FIG. 2—THE CRANE FROM THE STOCK-YARD TRAVELS ACROSS THE FLOOR OF THE OPEN-HEARTH CHARGING PLATFORM

FIG. 1—METAL IS PUT INTO THE FURNACE WITH A CHARGING MACHINE HELD BY A CRANE AND OPERATED BY THREE MEN—NOTE THE WHEEL FOR TURNING THE BOX

the regenerator to metal capacity gives the most efficient operating results. The doors of the furnace are cooled with running water and are raised and lowered by compressed air which is controlled by valves centralized at one station near the wall in front of the furnace.

The charge is brought from the stockyard in charging boxes carried on flat-bottom cars. Each box holds 1300 pounds of pig iron or scrap and three boxes are carried by each car. The metal is loaded into the boxes by a magnet on a crane and the cars are carried to the charging platform by the same crane. The crane with its runway extending across the charging floor and along the stockyard is shown in Fig. 2. This also illustrates the method of unloading pig iron and scrap from the cars to the stock pile. The pits for storing the coal for the annealing furnaces may be seen under the railway car in the center foreground.

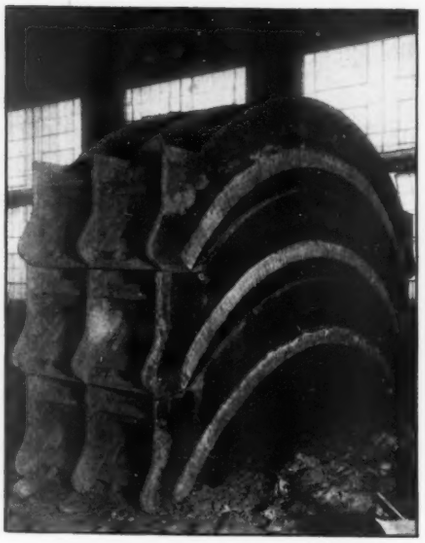


FIG. 4—ARCHES FOR THE ANNEALING OVEN ARE DESIGNED SO THAT THEY MAY BE PILED ON TOP OF EACH OTHER

The charge is made up of 16 to 17 per cent pig iron and the remainder scrap. At present a large proportion of the scrap consists of steel shell blanks which contain under 0.04 per cent sulphur and phosphorus. As the steel takes up only a few thousandths of 1 per cent sulphur from the oil fuel, the sulphur and phosphorus in the finished steel are kept low. In addition to pig iron and scrap, iron ore for reducing the carbon in the bath, sand for making and thinning the slag and deoxidizers are used in the melt. Pig iron is charged first and the scrap is placed on top of it.

A complete record of every heat is kept on a form as illustrated in Fig. 6. The record in this illustration shows an average heat taken after the furnace has been idle all night. Frequently a second heat is made in the same day. In such cases the time required is

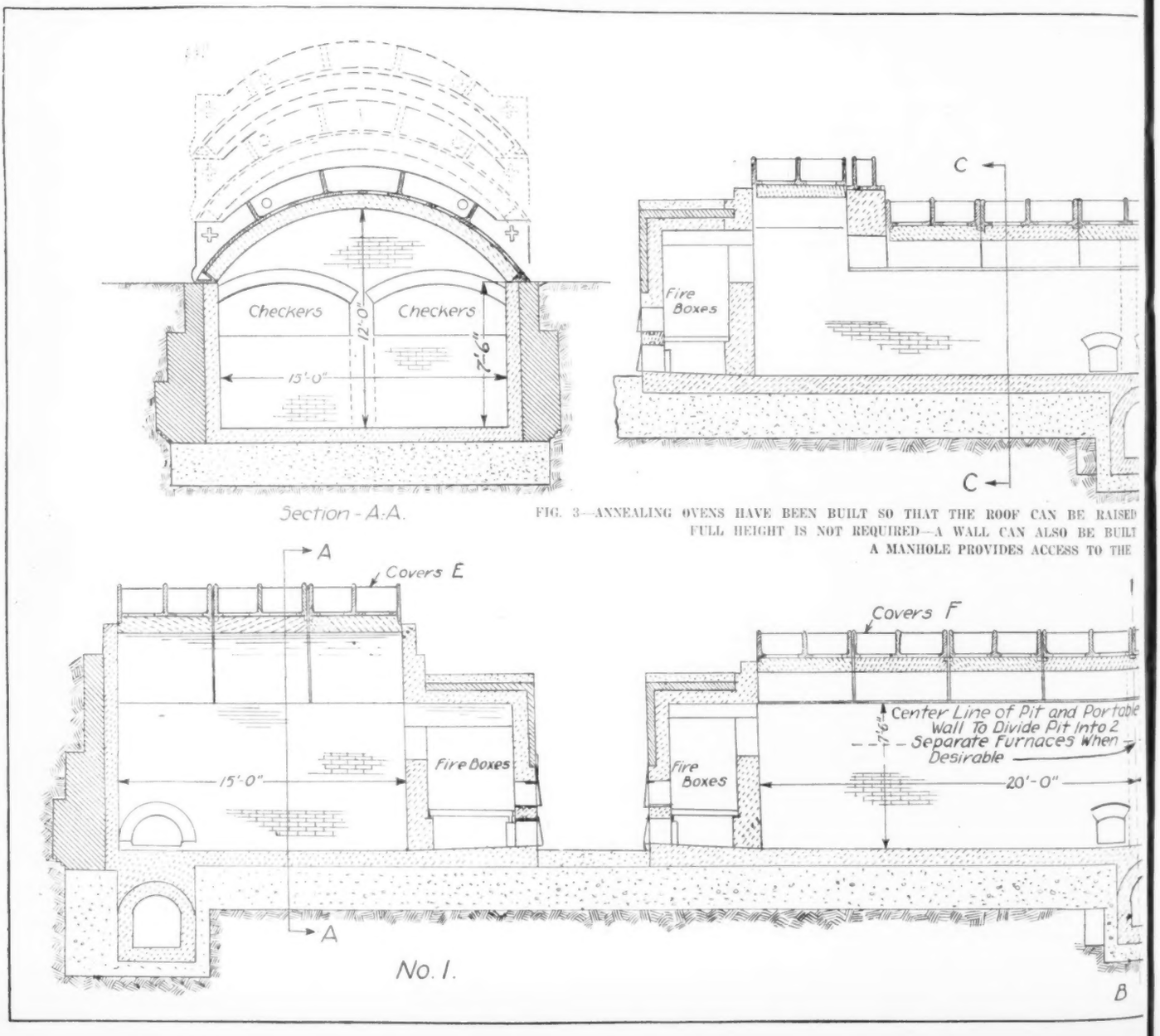


FIG. 3—ANNEALING OVENS HAVE BEEN BUILT SO THAT THE ROOF CAN BE RAISED FULL HEIGHT IS NOT REQUIRED—A WALL CAN ALSO BE BUILT A MANHOLE PROVIDES ACCESS TO THE

approximately 1½ hours shorter. The best record made so far with this furnace is 4 hours and 10 minutes for a heat. From the column at the left it may be seen that 16.9 per cent of the charge was made up of pig iron. The remainder of the charge consisted of 79.9 per cent scrap; 1.8 per cent 14 per cent ferrosilicon; 0.9 per cent of 79 per cent ferromanganese; and 0.5 per cent iron ore. This column is signed by the foreman of the charging gang.

The history of the heat is given in the right-hand column. Above is a table giving the time of operations. This shows the time the heat was started, the time charging was finished and when the heat was melted. In this case 3 hours and 10 minutes were required to charge the furnace and the heat was melted 1 hour and 55 minutes later.

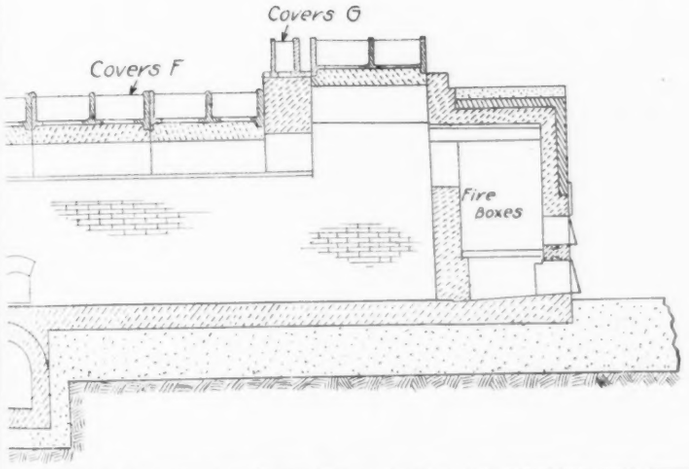
The time the final ladle additions were made is shown as well as the time the heat was tapped. Two lines are

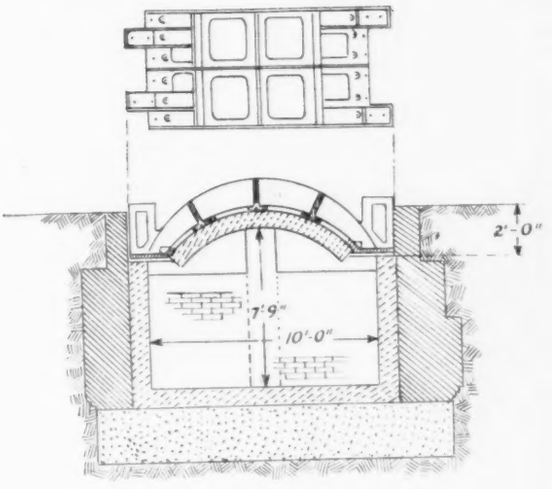
FIG. 5—VENTS LIKE THIS ONE ARE SPACED AT SHORT INTERVALS AROUND THE FOUNDRY AND SUPPLY FRESH HOT AIR

left for reporting the length of time and causes when there is a delay in tapping. The time required to make the heat from *commenced charging* to *tapped* is marked at the bottom. Delay between heats is recorded on the first line of this table.

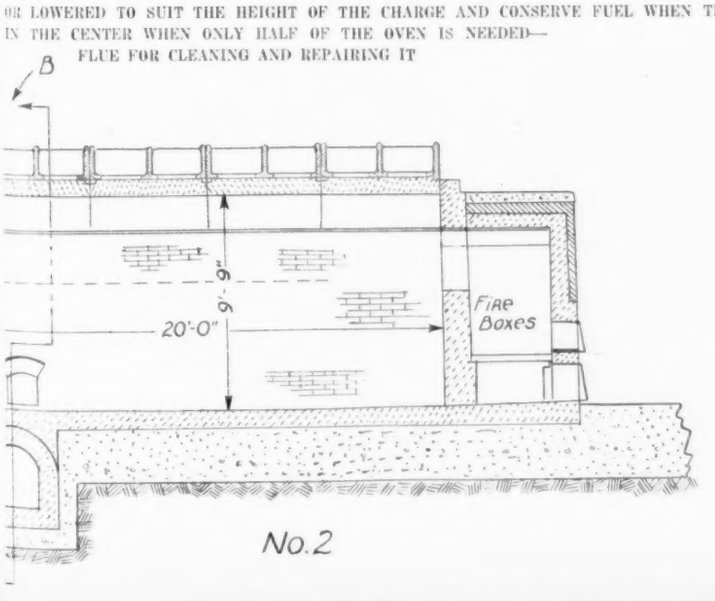
In the middle of the right-hand column is a table giving miscellaneous information such as size of nozzle, condition of stopper after pouring, causes for any trouble which might have occurred in pouring, weight of skull, oilmeter readings, etc. This section is signed by the melter foreman. The table below is signed by the chemist. This table gives the composition desired and the composition obtained with the results of any preliminary tests which have been made. There also is a space in this table for recording the results of a physical test of the steel.

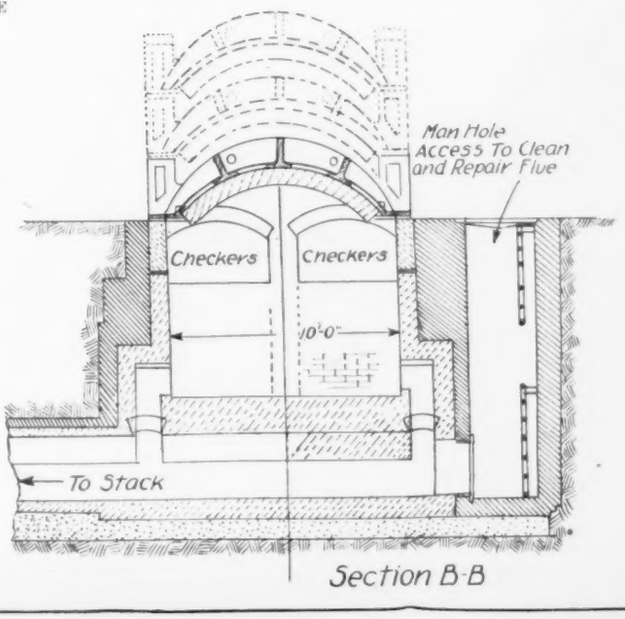
The metal is charged into the furnace by a machine built by Edgar E. Bro-





OR LOWERED TO SUIT THE HEIGHT OF THE CHARGE AND CONSERVE FUEL WHEN THE
IN THE CENTER WHEN ONLY HALF OF THE OVEN IS NEEDED—
FLUE FOR CLEANING AND REPAIRING IT





Form No 325-2-'19-1M-Pads 100 V-214156

VULCAN IRON WORKS—OPEN HEARTH FURNACE

DATE Oct. 28-19 REPORT HEAT NO. 47

MATERIAL		WEIGHT		%
CHARGE	Pig Iron	7	050	16.9
	" "			
	" "			
	" "			
	Washed Metal			
	Own Scrap	6	730	79.9
	Shell "	22	675	
	Misc. "	3	890	
	Total	40	345	
ADDITIONS	Ferro Silicon 10%			
	" " ~~25%~~ 14%		730	1.8
	" " 50%			
	" " 90%			
	Ferro Mang. 50%			
	" " 70%			
	" " ~~80%~~ 79%		365	.9
	Silico Manganese			
	Spiegeleisen			
	Silico Spiegel			
	Aluminum—Ladle			
	" Pouring			
	Nickel			
	Manganese Ore			
	Cliff Shaft Ore			
	Ferro Chrome Ore			
	Anthracite Coal			
	Pig Iron			
	Vanadium			
	Iron Ore		200	.5
Total Charge				100%
FLUXES	Iron Ore			
	Bottom Sand			
	Lime			

TIME OF OPERATIONS — HISTORY OF HEAT	Hours	Min.
Lost between heats	—	—
Commenced charging	10	35
Finished charging	1	45
Time required to charge	3	10
Melted	3	40
Time required to melt	1	55
Final additions made	4	35
Delayed in tapping	—	
Cause of delay	—	
Tapped	4	40
TIME REQUIRED TO MAKE HEAT FROM "COMMENCED CHARGING" TO "TAPPED"	6	05

Boil in ladle. (Yes or No)	No
Size of nozzle	2"
Condition of stopper after pouring	Good
If any trouble in pouring, give cause,	None
Weight of skull	None
Weight of spill, if any	None
Furnace working	Good
Number of heats for roof	47
" " " " " checkers	"
" " " " " port (north end)	"
" " " " " " (south end)	"
Reading of oil meter end of this heat	99880
" " " " " " last heat	99040
Gallons of oil required for this heat	840
" " " per ton steel	40.4

Thos R Dix MELTER FOREMAN

CHEMICAL AND PHYSICAL ANALYSIS

	CAR	MANG.	SIL.	SUL.	PHOS.	CU.
Specification desired	35/45	65/75	20/25	-04	-04	X
Comp. when melted						
1st preliminary test						
2nd " "						
3rd " "						
Added						
Final Composition	.37	.66	.25	.030	.038	

DESCRIPTION OF BAR	TENSILE	ELASTIC LIMIT	% ELONGATION	% CONTRACT'N	FRACTURE

Charged by Jos. Oates

John T. Culp Jr. Chemist

FIG. 8—A COMPLETE RECORD OF EVERY HEAT IS KEPT—THIS SHOWS WHAT MATERIALS WENT INTO THE FURNACE BESIDES GIVING THE TIME OF THE DIFFERENT STAGES IN THE OPERATION AND THE COMPOSITION OF THE FINISHED METAL

sius, Pittsburgh. This is shown in Fig. 1. In the regular charging operation three men are used at the wheel. The machine is held by the crane with two steel chains. The heaviest weight is borne by the chain nearest the wheel. As may be noted, a bucket weighted with metal acts as a counter balance to the weight of the loaded charging box. The chain near the bucket raises and lowers that end of the machine for lifting the bucket off the car. After the bucket is raised the crane moves it into the furnace. The man at the wheel then pulls the lever shown sticking horizontally from the bearing above the counter weight. This releases the shaft and allows the bucket to be turned by revolving the wheel. The lever directly in front of the wheel controls the plate on the end of the shaft, which engages the bucket. By changing the angle of slope of this plate the bucket is picked up or disengaged. When one box is emptied the crane moves the charging machine to the next box. After this box is engaged by the machine the crane moves back, carrying the car with it until it is in line with the furnace door for charging the engaged box.

All Oil Is Metered

The open-hearth furnace is fired with oil and all the oil is metered. It is interesting to note that not only is the oil metered as it goes into the main line but it is metered again at each place where it is used. Accurate metering is made possible by careful inspection of the oil before it is accepted and by a complete system of strainers. As soon as a car of oil is received an examination is made to see that it is clean and that it does not contain appreciable amounts of water. A gravity test is also made. This should show the oil, which is Pennsylvania crude, to be of approximately 30 degrees Be. gravity. If the oil is much heavier or contains a thick sediment it will clog the strainers and stop the flow through the line. The oil is put into two 60,000 gallon tanks when received. It passes through five strainers before entering the meters. Two 3-inch strainers are in the main line in the pump house and three 1¼-inch strainers on individual lines. These strainers clean the oil thoroughly and make possible the accurate working of the meters. The meters were supplied by the Pittsburgh Meter Co., East Pittsburgh, Pa.

The meters are checked at intervals by subtracting the amount in the tanks from the amount received and comparing this figure with the quantity the meters record. The tanks automatically indicate the height of the oil in them by a float on the outside of each tank which show the amount of oil in the tanks. The amount of oil used at the several stations is recorded on different reports and if too much is consumed, inquiry is made into the reason. This fact makes the operators use more care in conserving the oil and occasionally some change in the practice is found which reduces the amount of fuel oil required.

The operation of the different furnaces is controlled according to a system of pyrometers. These were installed by the Brown Instrument Co., Philadelphia, which sends a man occasionally to calibrate them and maintain their accuracy. Indicating pyrometers are located at the annealing ovens and at the drying ovens for the use of furnacemen. These indicators at the ovens are supplemented by four record-

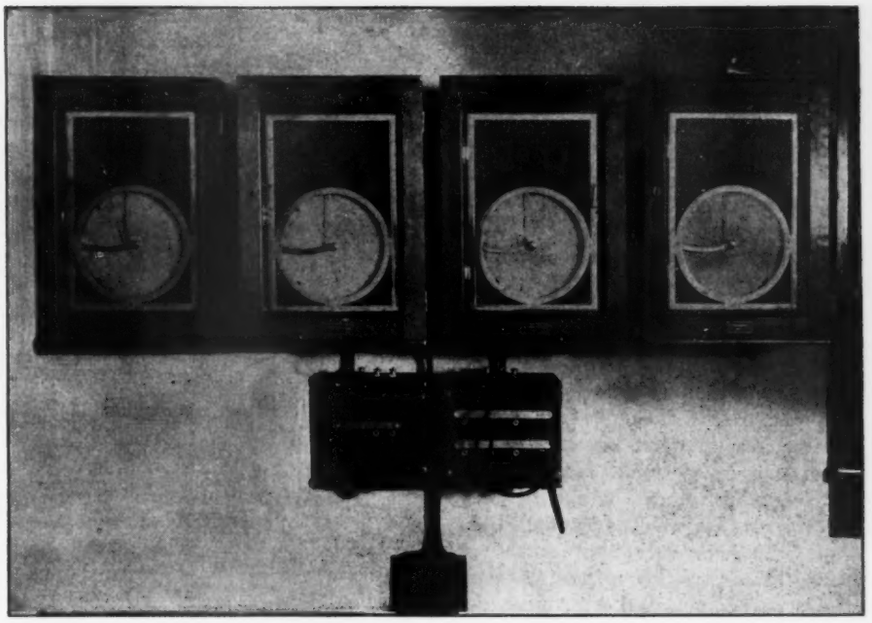


FIG. 8—PYROMETERS LOCATED IN THE SUPERINTENDENT'S OFFICE RECORD THE TEMPERATURES IN THE ANNEALING AND DRYING OVENS

FIG. 7—TWO SPECIAL BUNGS SHOWN NEXT TO THE SUNKEN COVERS HAVE BEEN DESIGNED TO FILL THE GAP BETWEEN THE PORT COVERS AND THE LOWERED ROOF—THE VOLUME OF THE OVEN IS INCREASED BY RAISING THE BUNGS

ing pyrometers in the superintendent's office. Both an indicating and a recording instrument measure the temperature at one place in an oven. This affords an opportunity to check the accuracy of one with the other and such a check frequently is made. The recording instruments in the superintendent's office are shown in Fig. 8. Either of the two instruments at the left may be connected with any one of the thermocouples in the annealing ovens through the four-plug connection box underneath. However, only one couple can be connected with an instrument at one time. This is ample for present requirements, as there are never more than two operated simultaneously.

The two instruments to the right can be connected to couples in the drying ovens. Like the recorders for the annealing ovens, neither of these instruments can be connected with more than one thermocouple at the same time. More recording instruments will be added as needed and these can be connected with thermocouples through the eight-point switch which it is thought will provide for any growth in the near future. The foundry foremen have free access to the recorders in the superintendent's office and consult them frequently. The charts are kept for reference and are consulted in case any unusual condition arises during casting, or if there are any defects in the castings which may be attributed to improper drying of the molds or to the method of annealing. A customer may see from the charts of the annealing ovens just what heat treatment has been given his castings, and the foreman of the annealing room may assure himself that the furnace has been kept at the specified temperature during the anneal. Each chart records the temperature for 24 hours, but the chart may be left on more than 24 hours without the recording lines crossing each other if the furnace is coming up to temperature or cooling. The instruments are actuated by individual 8-day spring mechanisms, but they are wound twice a week to insure against irregularity in operation.

The Vulcan company lays stress on the advantage of keeping the workmen comfortable. One means for doing this is by maintaining a warm, well ventilated foundry. This is insured by a thorough heating and ventilating system. Exhaust steam is brought from the central power house to a radiator room in the foundry building. Air is sucked through the radiators by a fan. This heated air is then forced to all parts of the building through pipes and blown out through screen-protected registers located at short intervals along the walls and at the center line of girders. One of these radiators is shown in Fig. 5. The center line of the registers is 36 inches from the floor and the top is slightly over 5 feet high. The efficiency of this heating may be appreciated from the remark of one of the molders who said, "I like to get in here in the morning because it is warm as toast."

Will Build Large Addition

The Northwest Foundries, Inc., Rochester, N. Y., has prepared plans for a new two-story addition, 197 x 250 feet, to provide for needed expansion. The company, which was formed in 1912 as the Northwest Aluminum & Brass Foundry, later built a gray iron foundry and incorporated in 1914 as the Northwest Foundries, Inc. The present addition, which will be constructed under direction of Joseph H. Oberlies, architect, will triple the present capacity of the plant. The officers of the company are: President, Charles E. Tepper; vice president, John R. Loysen; treasurer, George A. Hetzler; secretary and manager, Herman G. Hetzler.

Plaster of Paris Molds

Question: I am having considerable trouble making plaster of paris molds. The plaster sticks to both wood and iron patterns and I experience considerable difficulty in drawing them out of the molds. How should the patterns be treated to overcome this trouble?

Answer: Plaster of paris is used in the foundry for two purposes. One is for making patterns and follow boards and the other is for making molds in which metal is to be cast. If used for the former purpose it will dry sufficiently hard at ordinary atmospheric temperature; but if it is used as a mold in which molten metal is to be poured it must be heated to expell all the moisture.

The method of preparing the plaster impressions is the same in both cases and does not differ materially from the preparation of a sand mold. The patterns and parting must be oiled to prevent the plaster from sticking to them. Any kind of lubricating oil will answer the purpose.

For illustration consider an ordinary solid dumbbell pattern and proceed step by step to make a plaster mold. The cope of a small iron flask is set on a board, joint side up, filled with sand, rammed and struck off. A small hollow is scraped out and the pattern bedded in half way. A parting is then made and the exposed part of the pattern oiled. The drag part of the flask is then set on and plaster which has been mixed to the consistency of thick claywash, is poured in until the flask is filled. The plaster is allowed to set for about half an hour. The two parts of the flask then are rolled over, the cope taken off and the sand shaken out. The joint is cleaned and scraped after which both joint and pattern are brushed with oil. Then the cope is replaced, gate and gate sticks, also oiled, are set in place and plaster is poured in as in the case of the drag. When the plaster has set the cope is lifted off and the pattern taken out. The mold then is dried in an oven or elsewhere after which it is ready to be assembled and the casting poured.

In the event that no iron flask is available a wooden one may be used but of course it must be removed before taking the mold apart. After the frame is taken off suitable marks can be scratched in the plaster wall at the joint to serve in relocating the two parts of the mold after they are dried.

Business Changes Made

The Iron Trade Products Co., Farmers Bank building, Pittsburgh, has increased its capital stock to $200,000. W. J. Strassburger remains as president and J. L. Hukill has been elected vice president; L. J. Adler, treasurer; E. M. Moreland, sales manager steel department; C. E. Kitchen, manager coal department. Mr. Moreland has been connected with the Carnegie Steel Co. for the past 15 years, resigning his position as assistant to W. P. Siebert, assistant general manager of sales, to join the Iron Trade Products Co. Mr. Kitchen was formerly car distributor for the Pennsylvania lines, then with the Valley Camp Coal Co., and for the past four or five years with the Fort Pitt Coal & Coke Co., Pittsburgh, as general manager of sales.

John Hierwarter has a building, 24 x 60 feet, under construction at 252-254 Wilson avenue, Kearny, N. J., which will be known as the Eagle Brass Foundry and devoted to the making of brass, bronze and aluminum castings.

The American Metallurgical Corp. has opened an office at Credland Chambers, 111 Queen St., Sheffield, England. This office will be under direction of Beecroft & Partners, Staffordshire and G. C. Castle will be directly in charge.

The Bridgeport Brass Co., Bridgeport, Conn., has formed a class of 73 men to follow a course in production methods which will be directed by the Business Training Corp., New York.

Steel Casting Standards Outlined

Breaking Down of Secrecy Relative to Manufacturing Methods Exercised a Decided Influence on Steel Foundry Practice During the War—Characteristics of Ideal Castings Outlined

BY H. A. NEEL

EACH branch of modern manufacture has evolved its own recognized standards of value and quality, which furnish protection to everyone dealing in that commodity. The protection is mutual, assuring the seller that the quality of his goods will be fairly judged and furnishing the buyer a criterion by which to judge. Such standards sometimes are established by taking the best known commercial practice as a working basis, and sometimes boldly over-reaching commercial practice, by requiring the manufacturer to revise his methods to meet the new demand. The establishment of standards is coincident with the birth of a new industry, and failure to establish them inevitably results in high infant industry mortality.

The primary impulse for standardization of an industry may come from within the industry, or may be a result of concerted demands from the consumers. An excellent example of what can be done by mutual action by the producers in any given line to improve their product is afforded by the progress made in malleable practice, in the last few years, due to the research work and interchange of ideas fostered by the malleable interests. Co-operation between producer and consumer in any line will achieve like results.

Secrecy Broken Down

The war was of great benefit to the steel casting companies in breaking down traditional secrecy regarding methods of manufacture. The general dissemination of information as to good practice through the medium of the ordnance department did much to raise the standard of steel castings generally; although it also militated against the highest quality.

If we take for granted that the buyer has been convinced it pays to buy the highest grade of steel castings because of the greater reliability of the product manufactured from them, and because of the saving in machine work on defective castings, what has he the right to expect and require in his castings?

The four fundamentals to a good casting are metal, molding, finish and design.

The first consideration in the metal is the process by which it is made, which will be either open-hearth, converter or electric furnace. Good steel can be made by any one of the three processes, but the best results are to be expected from the electric furnace. This is true because, granted that the operators in all three processes are of equal intelligence and skill, the electric furnace melter has the advantage of the superior tool.

Checking Physical Properties

Chemical analysis of the steel should be left to the manufacturer, especially if physical properties are specified. In specifying physical properties one immediately is confronted with the paradox in the fact that although of uniform analysis chemically, there is a decided difference physically in different parts of the same casting, due to different conditions of feeding and cooling. It is difficult to get an acceptable physical test from a section less than an inch in thickness, because the density is low due to rapid cooling from liquid to solid state. The most satisfactory way of checking physical properties is by use of a standard test bar gated to the casting. Either S. A. E. or A. S. T. M. physical specifications are reasonable, but it is wise not to place too great emphasis on the sulphur clause in the chemical specifications. Good castings are not made or ruined by thousandths of a per cent of sulphur.

Given steel of proper physical qualities, it should further be free from sand or slag inclusions, and from cracks, checks, shrinks, strains or blow holes. The machined surface of a steel casting should show clean, solid metal, if proper care has been taken in its production. At the same time, it is wrong to reject a casting for a minor flaw provided it does not impair the usefulness or reduce the factor of safety.

Next in importance to the metal is the design of the casting. Too often the engineer places foundry problems last in his design work. About 50 per cent of the loss in casting practice is due to lack of co-operation in working out a design which, while answering its purpose, will permit proper feeding of all sections and relief of all cooling strains. Also a casting must provide sufficient finish on machined surfaces to take care of allowable variations in molding. An eighth of an inch is minimum for finish.

The molding practice should be such that the casting is true to pattern, free from scabs, blows and dirt in the surface. From the machine shop's standpoint, the presence of slag or sand, either sticking to the surface of the casting or just under the surface is annoying and expensive.

For some uses the surface appearance of castings is important. Sand blasting and tumbling are essential to remove molding sand and annealing scale. All fins and brackets should be chipped off and the surfaces where beads and risers have been removed ground flush. Sloppy welds or battered corners should not be permitted.

The foregoing constitute some of the points the buyer has a right to expect as standard. Consider what the foundry has a right to expect in return. First of all the manufacturer should expect a fair price for his product. The production of small, high-quality castings involves a high labor cost. One-half the entire cost of castings is paid in wages.

Experimental Work Necessary

The next most important factor after price is continuity of work. Few patterns can be put in the sand and production started until extensive experimental work has been done. Given the same pattern, five good foundrymen will have five different ways of gating, risering and chilling it. Only by experiment can the best way be determined. Therefore, every pattern represents a certain amount of research work. For this the customer pays. If orders are placed at a different foundry every time a supply of castings is needed, the customer pays this item repeatedly. Meanwhile the foundry loses money unless high prices are named on all such orders.

Abstracted from a paper presented at a joint meeting of the Cleveland chapter of the American Steel Treater's society and the Steel Treating Research society, March 1, 1919. The author, H. A. Neel, is metallurgist for the Michigan Steel Casting Co., Detroit.

As important as either price or continuity of orders is co-operation between foundry and machine shop. Often good castings are rejected when they do not machine to blue print dimensions, because the machine shop foreman insists on jigging them a certain way, or laying out from a certain surface. Foundry work at best is an approximate rather than an exact science, and a realization of the fact that certain castings have to be favored in machining will save money to both sides.

Welding Castings

Another point at which money may be saved by co-operation is in the salvaging of castings developing minor defects in machining. Common practice is to return all defective castings to the foundry, regardless of how much machine work has been done. In castings which are known to be subject to flaws at certain points, these points should be machined first. Usually, if flaws are discovered soon enough, they can be welded, and the casting saved, whereas if the bulk of the machining has been done, welding will warp the castings sufficiently to render it useless. It is better for the foundry to pay a welding charge than to have the casting scrapped, and better for the customer to salvage the casting and save the machine cost.

Foundry standards here presented may be said to represent accepted practice today in the better class of foundries. If our standards are fixed on this basis alone, the tendency for improvement will not be great. To stimulate the industry, it is necessary that greater demands be made in the way of improved physical properties. It may be said that heat treatment yields as great proportionate increase in the physical properties of cast steel as in rolled steel.

All castings which are subjected to shock, strain or vibration should be annealed. Usual practice calls for a temperature of 1600 degrees to 1650 degrees Fahr. for a time sufficient to break up the original coarse crystalline structure. The old rule of an hour's time per inch of thickness is good. If the best machining qualities are desired, the castings should be oven cooled to a point below the critical range. When a slightly greater strength than that of the annealed castings is desired, an air quenching from 1600 degrees Fahr. will materially increase the elastic limit. As might be expected, this treatment shows greater proportionate increase in strength for high carbon steels than for low carbon. Little draw is required on steels containing under 0.25 carbon, but is quite necessary on the higher carbon classes of steel.

Water or oil quenching are applied to castings the same as to forgings, but greater care must be used in handling the castings, due to the possible presence of unrelieved casting strains or incipient cracks at insufficiently filleted corners. The quenching temperature for steel castings should be higher than for forgings of the same analysis. The higher temperature is necessary to break up the closely crystalline structure of the steel as cast. All precautions against warping in quenching that are usually observed in handling forgings, apply with equal force to castings. The drawing heat for castings must be higher than for forgings of equal ductility, and usually drawing time must be longer.

At various times, we have made castings of almost all the more common types of alloy steel. Our physical results check very closely with forged steel of like analysis on ultimate strength and yield point, but ductility is somewhat lower and Brinell hardness is higher. The percentage increase in the various properties, due to use of alloys and heat treatment is as great for cast steel as for forged steel. However, it would be wasted effort to make high grade steel and subject the castings to expensive heat treatment unless those castings were good from a foundry standpoint.

Ladle Juggling in an Eastern Foundry

By Job Goostray

"Bill's" description of some ladle juggling in the Jan. 1 issue of THE FOUNDRY reminds me of some of my experiences in that line. About 20 years ago a small foundry in the east contracted with a new shipbuilding company to make seven sections of castings for a steam hammer block. These castings weighed from 28 tons to 32 tons each. The only crane in the foundry was a 5-ton locomotive crane running on a standard gage railroad track through the center of the shop. The melting equipment of the shop consisted of one 22-ton air furnace, one 42-inch and one 30-inch cupola. In molding these blocks a dry sand facing was used and the molds were well dried. Two pits were dug and while one casting was being cooled off another was being molded. Two 15-ton tanks or reservoirs were used supplemented by a 4-ton ladle. Each cope was made in two sections for convenience in handling. After each casting had cooled sufficiently the sand was removed from around it and arrangements were made with a building mover to take it out of the shop and place it on a lighter, there being a place about 500 yards from the foundry, where each in turn was loaded and towed down to the shipyard. These castings were removed from the shop at night and therefore the performance did not interfere with the usual shop routine in the day time. As there was no means at hand for weighing these castings, the draftsman measured them and his approximated weight was accepted.

The casting pit in this shop was 16 feet in diameter and 16 feet deep which made it possible to make castings up to 20 feet long. Frequently castings were made weighing from 5 to 18 tons; and it was no uncommon sight to see two and three ladles of 4 or 5 tons capacity hanging from beams or trusses of the building which were about 18 feet from the floor. A chain was wrapped around the beam from which to suspend the ladle, and an upright post with a jack-screw under it was utilized to support the beam near the point of suspension. A changing hook was used with the ladle so that when it was filled with iron it could be changed over to a loop in the chain attached to the beam. These ladles were always tried in the place where they were intended to go before any iron was put in them. No mold, including the runner box, could be over 5½ feet above the floor as the ladle could not be emptied by the crane above that height. I have seen the ladle on the crane started and emptied first and while the other ladles were being poured the empty ladle on the crane would be lowered off and another one picked up and used.

This small foundry made the two large cylinders weighing 19 tons each for the first battleship built by the shipbuilding company. They also made a large number of manganese bronze castings for two cruisers. This metal was melted in the air furnace, as much as 15 tons being melted at one time. A fire brick bottom was laid in the furnace and the furnace was well heated up before the metal was charged. In pouring some of these manganese bronze castings it also was necessary to use three ladles, hanging two of them on the beam while the crane took the third.

The Magnetic Mfg. Co., Milwaukee, manufacturer of magnetic separators for foundries and smelters, is building a new plant, 60 x 120 feet, of brick and steel construction.

Electrical Melting of Alloys—II

Essential and Desirable Features of Furnaces for Melting Nonferrous Metals Are Outlined and Distinctions Are Drawn Between Their Relative Merits

BY H. W. GILLETT

Surveying the Field

THE first of this series, which was presented in the March 1 issue of THE FOUNDRY, *demonstrated the advantages which can and are being obtained through electric brass melting. This article points out the factors which affect the ability of a furnace to give those advantages. Both of these considerations are discussed in a broad and analytical manner. In the succeeding parts of the series, different types of melting units will be considered and specific data offered explaining the merits and limitations of each.*

FUNDAMENTAL advantages of electric furnaces have been noted in the preceding article. As no electric furnace has them all in an equal degree, it is necessary to consider what is essential, and what is merely desirable, as well as the relative importance of the desirable features to the purposes for which the furnace is intended. These features may be summarized as:

Ability to produce satisfactory quality.
- (*a*) As to freedom from oxygen, dissolved gases, etc.
- (*b*) As to uniformity of composition.
- (*c*) As to temperature.

Ability to melt with low metal losses.
- (*a*) Gross loss.
- (*b*) Net loss.

High reliability.

Dependability of parts in the hot zone.
- (*a*) Long life of refractories.
- (*b*) Long life of electrodes.
- (*c*) Rapid repair or replacement of refractories or electrodes.

Dependability of parts outside the hot zone.

High rate of production.
- (*a*) As to floor space.
- (*b*) As to labor.
- (*c*) As to initial investment.

High thermal efficiency, i. e., low power cost per ton.
- (*a*) Inherent design.
- (*b*) Suitability for rapid operation.

Versatility.
- (*a*) As to operating on different alloys and changing from one alloy to another.
- (b) As to operating a few hours per day or continuously.
- (*c*) As to pouring either into ladle or direct into molds.

Convenience.
- (*a*) Fool-proof-ness.
- (*b*) Healthfulness and comfort for operators.

Good electrical characteristics.

Low first cost.

If any one type of furnace excelled all others in every one of these points, it would approach the ideal furnace, and it would suffice merely to describe this one best furnace. But there is "no such animal."

All the commercially useful electric brass furnaces are compromises. Each excells in one or more features and falls short in others. When the good features coincide with the more essential requirements of a plant melting brass, and the points on which sacrifice has been made are not imperative to ideal performance, the furnace will be useful.

There is only one point on which no compromise can be made. The furnace must produce a satisfactory quality of metal. It should be a brass furnace first and an electric furnace second.

There is no metal or alloy that can be melted by any known means that cannot be melted electrically in some furnace so as to produce a satisfactory quality of product. There may be a few rare cases where it is difficult to do this cheaply enough.

Good metal is obtained by securing freedom from oxygen, sulphur, dissolved gases, etc. This means that the furnace to produce the best metal must be capable of being operated while tightly closed. Most types of electric furnaces maintain an automatically reducing atmosphere, which is advantageous on most copper alloys. However, the Philadelphia mint* has found that even in a furnace with a reducing atmosphere it is necessary to keep the furnace closed to get the highest quality of cupronickel or bronze. Since good metal probably is as important in minting operations as anywhere, this testimony is worth the attention of careless electric furnace operators who do not use every effort to keep the furnace closed. When an alloy after melting reacts chemically with hearth lining materials, so that detrimental impurities are taken up, the hearth material has to be chosen with care. One would not melt aluminum on a silica hearth. Uniformity of product always is desirable and sometimes essential. Therefore, furnaces which mix the charge automatically have an advantage over those requiring hand stirring.

Quality of product depends to some extent upon the uniformity of temperature in a given heat and in different heats. Therefore, those furnaces in which the temperature is under the closest control and in which after shutting off the current, the charge neither cools rapidly nor continues to heat rapidly, because of excessive heat storage in the walls, are more valuable.

The ability to melt with low metal loss always is highly desirable. Under American conditions, it is almost essential, because the saving of metal usually is one of the main factors in showing a balance on the right side of the ledger. In some European countries where electricity generated by water power is exceedingly cheap and fuel is excessively dear, they can afford to waste some metal to utilize the cheaper source of heat. Here, fuel is still the cheaper, generally speaking, and we have to make up for the extra cost of electric heat. Therefore, we cannot afford to pick an electric furnace indiscriminately but must choose or develop the furnace for the work.

America has developed special electric brass furnaces with a view to metal savings. Europe has done little on electric brass melting and that little has been in adapting to nonferrous melting those electric furnaces designed for melting steel or ferromanganese. Some of these furnaces of European design are doing good work in America in their limited field, but developing the field of nonferrous alloy melting is purely an

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*Baker, R. T., Report of the Director of the Mint, 1918, p. 12; see also Report for 1919, p. 13.

American achievement. Incidentally, it is of interest that the only contribution of Germany to progress in this field has been to show what not to do.

With a tightly closed furnace both gross and net metal losses are low, since oxidation that causes slagging and formation of dross to entangle metal is minimized and volatile metals are retained. Perhaps the most spectacular performance of an electric furnace was at the Philadelphia mint, where over 3,000,000 pounds of silver dollars were remelted with a metal loss of 1/100 of 1 per cent. This phenomenal figure is due as much to careful operation as to electric melting. The furnace used would give excessive losses on yellow brass. However, credit must be given to the electric furnace, since the mint states that the loss was lower than it can reach in crucible practice.

We now come to a series of factors which are desirable but on which a sacrifice can be made if thereby we gain sufficient other advantages.

First among these is reliability. The furnace should stand up to its work day in and day out without frequent forced shut-downs for repairs. Primarily, this means that the life of the lining should be long. Unfortunately, the best way to melt quickly and cheaply is to force electric power into the furnace. The more power that is fed to a given furnace the shorter is the life of its lining. Some makers prefer to build a furnace so that its roof, the weakest part in most types, can be placed quickly by a spare one, just as is done in electric steel furnace practice. Some go to the other extreme, cut down the rate of power input so that the furnace is slow and inefficient, but rarely needs repair. Others steer a middle course. Some use expensive refractories, intended to give long life. Others accept a short life and use the cheapest refractories possible; while still others compromise. The decision as to rate of power input and quality of refractories largely is determined by the type and design of the furnace from other viewpoints.

Simplicity Desired

Not only the refractories, but everything in the hot zone, such as the electrodes which carry the current from outside the furnace to the points where the heat is generated, or resistors (parts of the furnace, in its passage through which, the current generates heat), if either are used, should either be long-lived or else readily replaceable while the furnace is hot. Simplicity in the hot zone of an electric furnace is indispensable. Complexity or *fussy* construction is fatal to reliability. Many schemes for electric brass furnaces that look fine in the patent specifications have foundered on the rock of complexity in the hot zone.

Simplicity of the furnace outside the hot zone also is desirable, but where complexity carries with it advantages as to reduction of the attention needed, thus cutting labor cost, or where it gives thorough mixing of the metal, ability to get high production, etc., it often is justified. However, all delicate or complex construction must be where it can be attended to and kept in shape, and not in the hot zone. Mechanical and structural robustness and solidity are everywhere desirable. A flimsy furnace is no furnace at all.

Application of Heat

Next to reliability comes the capacity for a high rate of production. This may be primarily important to conserve floor space, labor cost, or money invested, all three being important. We can get a high rate of production by putting a great quantity of heat into the furnace, and by not wasting what we do put in. Rate of production is so tied up with thermal efficiency that both may best be considered together.

The electrical energy supplied to a furnace is all transformed into heat without loss. But heat cannot be confined. All one can do is to supply it fast enough so that there is enough to do the work desired as well as to compensate for the rate of leakage. Part of the heat supplied does useful work, some of it heats up the furnace walls, and a portion escapes through the furnace walls, electrodes, etc. That greatest source of head loss in a fuel-fired furnace, the gases of combustion, is avoided in the electric furnace, but the wall losses still are present.

The heat supplied is divided between useful heat and lost heat. As the amount of loss through the walls does not increase proportionally with an increase in the total heat supply, it follows that the more power forced into a furnace in a given time the more there is that can do useful work. Hence the faster is the rate of production and the lower the power consumption per ton of product. If two sister furnaces —furnaces, like ships, surely are feminine—are supplied with power, one at the rate of 300 kilowatts and the other at 400 kilowatts, the latter will turn out more work and do it with fewer kilowatt hours per ton. The higher powered furnaces are more efficient.

Care must be taken that in boosting the rate of power input heat is not supplied so rapidly that the furnace gets too hot or the temperature too localized for the refractories to stand up, or the charge to take up the heat without becoming locally overheated. Overheating would result in inability to keep the furnace tight, due to pressure of volatilized metals, and in loss of such metals.

Having decided the maximum rate of power input that the furnace lining or the alloy to be melted in a given furnace can stand, the next step is to see that as little as possible of the heat gets away. Heat loss can be minimized by using care in the inherent design of the furnace, by insuring the right thermal insulation, and by proper operation.

The best way to design a furnace to retain the heat is to locate the source of heat inside the metal to be melted, or just as close to the metal as possible. If for some reason, as exists on many alloys, the heat element cannot be in proximity to the metal, the heat should be made to travel to the metal by the most direct path, without baffling it by crucible walls or forcing it to turn corners. Heat radiation, like light, radiates from its source in all directions and in practically straight lines. All the radiation that isn't caught directly by the metal has to be reflected back and forth from the furnace walls till it hits the metal. However, every time it hits a wall, part of the heat leaks out and only part finally reaches the metal.

For these reasons indirect transfer of heat from its source to the metal is less efficient and results in a lower rate of production for a given power input. Waste space inside the furnace is poor practice, as it means a larger furnace and more wall area to leak heat. The more compact the furnace, the more efficient it is.

We can retard heat leakage through the furnace walls by building them of materials so chosen and arranged as to combine refractoriness and maximum heat retention. Therefore, thicker walls, more expensive refractories and more different layers of refractories than in fuel-fired furnaces generally are used because the electric heat it is sought to save is more expensive than heat from fuel.

Rapid Charging Aids

A hot furnace leaks heat through the walls whether it is melting metal or standing idle during charging and pouring, or while cooling off at night. Therefore, the relative amount of leakage may be cut down by designing it for rapid, preferably mechanical, charging and for rapid pouring.

A furnace is meant to melt metal, not to hold it after it is ready to pour, or to stand idle between heats due to slow charging and pouring. It means a lower power consumption and lower cost per ton to keep the furnace as busy as possible at its own job—that of melting. A few minutes lost in charging, a few more in pouring, and a few more holding the metal waiting for

molds, repeated each heat or now and then, soon add up to enough time to make another heat, which could just as well be obtained and at a low overhead, labor and power cost.

Similarly, if an electric furnace can be operated 24 hours, or even 16 hours, instead of only 8 to 10 hours per day, the heat leakage over night or between shifts is greatly reduced. Since on 8 or 10-hour operation it takes a long time to put that lost heat back into the walls and get the furnace fully hot once more, the first one or two heats of the day are slow heats. This results in reduced production and increased power consumption per ton. Of course, enough heat can be supplied at night to keep pace with the leakage. This is necessary on some types of furnaces to keep them in running condition or to get reasonable production during the day, but power to feed leaks costs money just as does power usefully employed.

Low Efficiency Balanced

While a high rate of production and high efficiency in the use of power always are desirable and become more and more necessary when the cost of power is high, their lack may not make the use of an electric furnace impractical or undesirable, if balanced by other advantages.

One firm, using to their great satisfaction, an efficient type of furnace 24 hours a day and melting at an average of 250 kilowatt hours per ton, states that its furnaces could not be used on 10-hour operation because they have to be kept hot at night, and "the energy cost would be too high." Ten hour operation would raise the power consumption to 325 kilowatt hours per ton, and the cost about 75 cents per ton.

Another firm, using a relatively inefficient type furnace for occasional heats only, keeps its furnace hot all the time, to have it ready for use, and reports that in a certain four months' operation the average power consumption was 2900 kilowatt hours per ton. This company says, "This furnace has proved very satisfactory, for our foundry work." Of course, the furnace can be operated far more efficiently.

The first firm is a large eastern rolling mill which does all its melting electrically, uses expensive, steam-generated power and aims for large production. The second is a large western mining company which uses cheap, hydro-electric power in huge quantities for other purposes, pays for it primarily on a basis of connected load, i. e., the maximum power the plant could draw from the power station at any moment. This company has to provide for some leeway between its normal load and its maximum load anyhow. Hence the power taken by this one furnace is but a drop in the bucket and it makes no practical difference in the company's power bills whether the furnace is run or not.

Circumstances certainly alter cases. Many other firms which have to make a heat of brass now and then would like to use an electric furnace, but when they have to pay 1 1/3 cents per kilowatt hour, the use of a furnace and of a method of operation that would require 2900 kilowatt hours per ton means that the cost of power alone would be some $38 per ton, while under the special conditions of this one firm, it costs practically nothing per ton.

Just as conditions alter the relative importance of economy in use of power, so do they affect the importance of the versatility of a furnace. A plant that has a huge output always can keep any one furnace busy on the alloy that furnace can melt the best; but a small jobbing shop must have a furnace that will handle any alloy to be melted, and preferably one that will do as good work on charges that are larger or smaller than the normal charge for the furnace.

If a plant is to work 24 hours a day, or two 8-hour shifts, it makes less difference whether the furnace will do good work on a single 8 to 10-hour shift, without night heating. But the plant that will never work at night needs a type not too badly handicapped on single-shift operation.

Some want to pour direct from the furnace into molds, and hence need a furnace that meets this requirement, while other would not do so if they could.

Furnaces Types Limited

It will be shown, in later articles of the series, that there is a vast difference in furnace types as to the range of alloys they can melt at all, or can melt efficiently, as well as to their ability to operate economically on single shift operation. Convenience and ease of operation, fool-proof qualities and the relative coolness and freedom from fumes, all vary with different types of furnaces. A furnace requiring inconvenient, hot, hand-charging might be endured for the sake of some other advantage, and the buyer often would pass a relatively fool-proof furnace for one requiring more attention but having a higher rate of production and a better efficiency on power consumption.

The electrical characteristics of a furnace may be either the first point, or the last, to demand consideration, depending on the location of the plant. In an establishment located in a small town, a furnace taking power from the plant's own generators or from a small central station may have to be chosen, as to type and size, almost solely in regard to the amount of disturbance it would cause to the generating system and the other users of power. Such a furnace might have to take power equally from all three phases of the generator, might have to be limited to 50 or 100 kilowatts and might not be allowed to have any rapid variations or surges in its use of power. There is one type of furnace, not so good as others for most conditions, that would fit this set of conditions.

On the other hand, a plant located in a big industrial city, usually can obtain all the power needed, up to 300 or 400 kilowatts per furnace, even if it is to be single-phase power for use on a direct arc furnace, with its violent fluctuations and surges. Of course the central station prefers the smoother and better balanced load, but it usually is so glad to get a chance to connect an electric furnace load to its lines that it is willing to accept the sort of furnace that will best meet the brass melting needs of its customer. As St. John* points out, the central station is an interested party in the installation and use of an electric furnace, and its engineers generally are both able and willing to help the furnace user on the purely electrical problems involved in the choice, installation and operation of the furnace.

Rarely is a foundry so located that it cannot choose an electric brass furnace on the basis of its performance as a brass melting furnace rather than on that of its electrical characteristics. Such outlying plants form the bulk of the small number that still can melt more economically by fuel than by electricity, because the electrical limitations may confine them to a choice of the less efficient electric furnaces.

Finally, the high first cost of any electric brass furnace may make it impossible for some of the smaller shops to finance the required capital investment. This seldom is true in a shop with a large enough and steady enough outfit otherwise to enable it to use an electric furnace to advantage.

Quantity Lowers Price

As electric brass furnace makers attain quantity production, prices will tend to fall. While the prices of some individual makes seem scarcely justified, prices of electric furnaces as a class are not unjustly high, nor do they often represent an unreasonable profit to the maker. The material and labor required to construct a staunch, reliable electric furnace are not cheap these days, and it must be remembered that much engineering and metallurgical skill must

(Concluded on page 238)

*St. John, H. M., Commercial Testing of Metallurgical Electric Furnaces, Chem. and Met. Eng., Vol. 21, 1919, p. 377.

How and Why in Brass Founding

By Charles Vickers

Pour Yellow Metal Hot

We experience considerable trouble from cold shuts and rough skin on the castings we make. We are using the following mixture: Ingot copper, 40 pounds; scrap sheet brass, 100 pounds; zinc, 3 pounds; lead, 3 pounds; phosphor copper, ½ ounce. We are using oil-sand cores, and the castings are very light and difficult to cast. We would appreciate any suggestions you may be able to offer.

The mixture given would be approximately: Copper, 75.50 per cent; zinc, 22.50 per cent; lead, 2.00 per cent. It would be greatly improved by the addition of about 2 per cent of tin, or 3 pounds of tin to the quantity of metal melted. The increased cost of the alloy might be compensated for by the larger amount of perfect castings.

In pouring yellow metal it is necessary to keep the sprues filled all the time that metal is flowing, in order to prevent zinc oxide which produces *smoky* castings, making them rough, from entering the mold. Also vents should be drawn from angles of the castings to the sides of the flasks, at the joint, to let off the gas generated. Yellow metal should be poured hot; that is, when smoking. As the castings are cold shut, it would appear they are being poured too slowly, or with too cool metal. Have the metal hot and pour as rapidly as the sprue will take it. In pouring yellow brass it is better to overflow the sprue onto the floor than to pour slowly, as is the case with red brass and bronze.

Casting Aluminum Around Steel Parts

We are making pressure cookers of cast aluminum and find difficulty from blowing on the part of steel chills which are cast into the body of the kettles near the top, on opposite sides. These chills are about one-half inch in diameter and seven-eighths long and form pivots for the bale that holds down the cover on the kettle. The pivots are cast in place and the aluminum blows off the head. Can you advise us how to avoid this difficulty?

The blowing is due to steam formed by the heat of the molten aluminum, and the steam comes from moisture condensed on the chills. The moisture comes from the damp sand of the mold and it condenses on the chill because the latter is colder than the sand of the mold. If the chills are warmer than the mold, no moisture can condense upon them, and there will be no blowing. If warm sand is used in making the molds, either on the face or in the backing, the mold will be warmer than the chill, dew will form on the latter, be raised to steam by the aluminum and form a hollow around the head of the chill. To overcome blowing, heat the chills just before pouring the molds. If the molds can be left open until a few minutes before pouring, the chills can be heated by a gasoline torch. It will be necessary to surround the chill with sand mixed with a solution of 1 part silicate soda to 4 parts water to avoid burning the sand. If the molds have to be closed some time before being poured, place a round copper rod in contact with the chill and have the rod extend through the side of the flask, and firmly fasten it there, just before pouring, heat the outer end of the copper rod, and the heat will travel to the chill, so that it will become hot and evaporate any condensed moisture. If there is no moisture on the chill, there will be no blowing.

Cleaning Brass Castings

We wish to be informed regarding the best method to clean small brass castings, such as pump parts. We make the castings for our own requirements and our consumption amounts to about 1000 pounds per year.

The best method of cleaning such small parts would be to tumble them in a small water tumbling barrel. Probably the smallest barrel that could be purchased would clean in a day, the entire year's consumption of castings. A water tumbling barrel lined with wood can be obtained from any foundry supply house. The small open mouth dry tumbling barrels are also excellent for clening small castings. In a case where the annual casting requirements are so small, money would be saved by closing the brass foundry, and purchasing the castings outside. The cleaning of the castings would then be up to the foundry producing them as needed.

Fumes from Yellow Brass

We would like to be informed if there is anything on the market that can be used in connection with yellow brass to prevent the heavy smoke that arises while pouring the metal into the molds? We are running a light fixture mixture, in which we cannot put any aluminum, and the men in the foundry are complaining about the fumes.

There is nothing that can be done to prevent the fumes arising while pouring yellow brass. These fumes are due to the zinc in the alloy. This metal melts at a lower temperature than the copper and at the temperature required to liquify the copper, the zinc becomes a gas and as such, is constantly distilled out of the mixture. The fumes are caused by the zinc vapor striking the air as it emerges. The result is that the zinc is immediately oxidized to zinc oxide which produces the white smoke and the little flakes, like snow that hang in the air. Aluminum modifies this condition because it produces a thin, but tenacious film of oxide over the surface of the molten brass, through which the zinc will only be distilled when the metal is very hot, in which case the zinc vapor accumulates under the film until it gathers sufficient pressure to disrupt the same and produce the smoke.

When aluminum cannot be used, there is nothing that can be done to mitigate the smoke. However, the molders and other workmen can protect themselves easily from the inconvenience of breathing this smoke. All that is required is to tie several thicknesses of cheese cloth over the mouth and nose. This should always be done when yellow metal is being poured. Simply have the men equipped with "flu" masks for protection.

Aluminum Not Magnetic

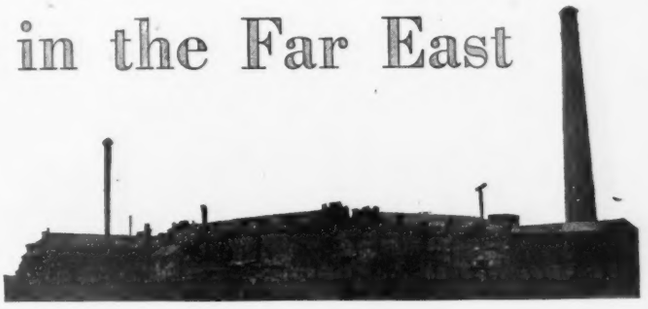
Can you advise us how to get the following alloys nonmagnetic? One alloy consists of copper 7 per cent; aluminum 93 per cent. The other is simply a lead casting.

Nothing need be done in the way of special treatment to ensure that the aluminum alloy, or the lead castings be nonmagnetic. In fact it would be exceedingly difficult, even impossible to make them otherwise than nonmagnetic, as they are nonmagnetic metals.

Foundry Practice in the Far East

Some Odd Angles of Castings Production in Japan and Russia Are Outlined

BY CHARLES C. LEE



Foundry and power house at Harbin, Manchuria

SIBERIA commonly is associated with everlasting snow and ice, with hordes of ravening wolves ready at a moment's notice to leave their lairs in the depths of the primeval forests and pursue the lonely traveler. Another familiar picture of this immense country visualizes the gang of political prisoners being flogged and driven like cattle over rough and ice covered roads to find their graves in the salt mines in that most northerly and desolate portion of Muscovite territory. How much of this popular impression is justified and how much is the result of sensational literature written by authors who relied mostly on vivid imagination for their material, it is difficult to say. In American vernacular, Siberia is "some" country; but having spent nearly two years in Manchuria on the Siberian frontier I am compelled to say that none of these grewsome conditions came under my observation.

Siberian Summers Warm

There are fundamental differences between the customs and habits of the people there and those in English speaking countries. To mention only one instance, the dead bodies of Chinese killed in clashes with the Bolsheviki were left lying where they fell until devoured by hogs which continually roam the streets. However, in general, life in Siberia moves much along normal lines and climatic conditions compare favorably with those of our northern states. Siberia popularly is supposed to be the coldest country in the world; yet the summers are quite warm, melons grow in the open air in some districts, and barley, sown in May will ripen by August. However, the summers are short and by November all the rivers are frozen. In the extreme north it is stated that the thermometer has recorded 75 degrees below zero, but the air is dry and an almost entire absence of wind makes the cold endurable.

For reasons which need not be discussed here, a detachment of the American Expeditionary Force known as the Russian Railway Service Corps was sent to Harbin, Manchuria in November, 1917, to exercise, among other duties, general supervision over the railway repair and maintenance shops of the Chinese Eastern railway. The railway regardless of its title, is Russian, and

Lieut. Charles C. Lee

Before entering the service Mr. Lee was superintendent for the South Bend Foundry Co., South Bend, Ind., and previously he held similar positions with the Studebaker Corp., South Bend, and the Gisholt Machine Co., Madison, Wis. He served two years with the Russian Railway Service Corps of the A. E. F. He is now with the Buick Motor Co., Flint, Mich.

is simply the eastern division of the Trans-Siberian railway. We are accustomed in America to railroading on a large scale. There are several transcontinental systems which link the Atlantic to the Pacific, but even in America there is no railroad system to compare with the great Russian railroad connecting Petrograd on the west with Vladivostok on the Pacific coast of Russian Asia, a distance of 6672 miles. A further extension runs down to Port Arthur on the southern tip of the Liao-Tung peninsula of Manchuria. It was only after this latter branch was built that China awoke to a realization of just what the concession she had granted Russia really meant. This railroad penetrates the most fertile as well as the most densely populated districts of Manchuria, and had for its terminal the Russian fortress of Port Arthur. On the north it joined with the Siberian trunk line at Harbin, on the mighty Sungaree river. It passed through the cities of Tsitsihar, Kirin, and Mukden, capitals of the three Manchurian provinces. It tapped the Gulf of Liao-Tung by the port of New-Chwang and skirted the whole eastern coast of this arm of the Yellow sea.

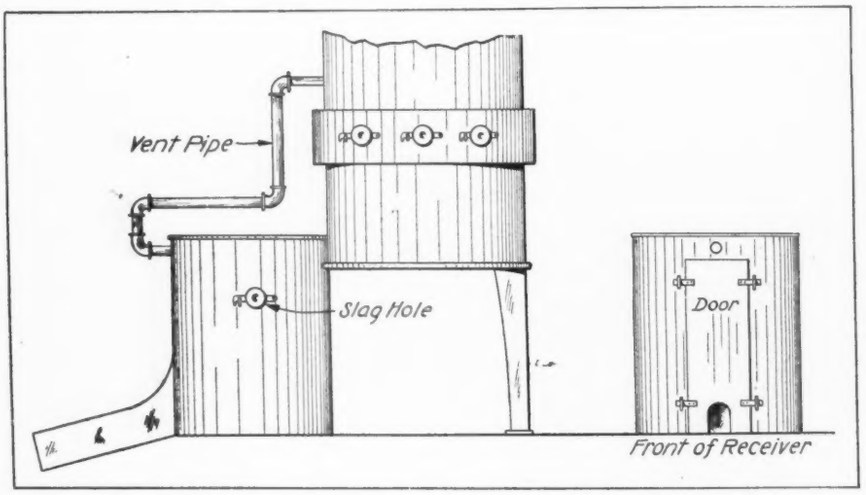
In 1904 Russia dispatched 300,000 troops over it in 90 days, accompanied by enormous quantities of provisions and supplies. However, in the world war, it proved wholly inadequate. Mountains of material were piled up at the terminals for months and sometimes for years; but in justice it should be stated that this condition was largely due to the disturbed political condition of the country. The railroad is a government institution and naturally the kaleidescopic changes in the government during the past few years were reflected in the operation of all public utilities.

Built in 11 Years

The first work on the road was done in May, 1891, and it was completed in its main features in 11 years including the branch line across Manchuria to Port Arthur and Dalny. The Siberian division proper starts at Tchelyabinsk on the eastern slope of the Urals and extends to Vladivostok following the fiftieth parallel for 4500 miles.

In perfecting the enterprise, Russia sent commissioners to the United States to study American railroad systems; imported Italian workmen who had helped to build the Simplon and St Gothard tunnels; built towns in deserts and transported thousands of families to them for the work. Many serious obstacles had to be overcome far from the base of supplies. Lake Baikal was a formidable barrier at first. Steamers transported the cars in summer and ice breaking steamers were employed for part of the long winter. The line was completed by building a 100-mile detour around the southern end of the lake in 1904.

The entire system was built cheaply with light rails and wooden bridges, but when formally opened in 1902, it had cost $172,525,000. However, it has proved a good investment, having given an impetus to agriculture and all other business throughout the district it serves. It is interesting to note that magnesite deposits in Manchuria are sufficiently well developed to show that they have a great potential value. According to the far eastern division of the commerce bureau the mineral is for the most part too pure to use for making bricks without the admixture of 7 to 8 per cent iron. The Japanese own the larger part of the deposits, but the Chinese still have considerable areas under their control. Associated with the magnesite are deposits of talc, which may be favorably compared with the high-grade French talc, but which have not been extensively developed. All of these deposits are from three to 10 miles from the South Manchurian railway.



EACH CUPOLA IS PROVIDED WITH A RECEIVER ATTACHED TO THE FRONT, INTO WHICH THE IRON TRICKLES AS IT MELTS—AT THE RIGHT IS A FRONT VIEW OF THE RECEIVER

The Russian Railway Service Corps of the A. E. F., comprising a contingent of approximately 300 men sailed from San Francisco on Nov. 19, 1917, for Honolulu. It was a calm and uneventful voyage of 10 days, only broken at one point when four days out by the receipt of a wireless message stating that there was a German raider in that part of the Pacific. The transport was unarmed, but she held on her course with all lights extinguished for two nights, and reached Honolulu in safety. After a stop of two days the vessel set out on the long northern leg of her journey and arrived at Vladivostok, Siberia, on Dec. 14, or Dec. 1 according to the Russian calendar. Between the time of sailing from Honolulu and arrival at Vladivostok, the Kerensky government had been thrown in the discard and the latter city was in control of the Bolsheviki. Therefore no attempt was made to land. After waiting for four days the vessel headed south arriving two days later at Nagasaki, Japan, where as soon as accommodations could be arranged, the contingent disembarked.

While in Nagasaki, Japan, it was found to be impossible to secure permission to visit any of the large modern shops; but several small, old-time, typical Japanese shops were inspected. The molding room in many of them is not much larger than a good sized living room. Such shops usually employ only one or two molders. Nearly all the work is made in the floor and weighted down for pouring. Instead of placing clamps on the few flasks in use they bind the cope and drag together with hay rope. A bar is placed across the top and one across the bottom. A double strand of hay or grass rope is used to connect the ends of the bars, after which a short stick is inserted in the loop and the rope twisted until perfectly tight. One molder or two, as the case may be, work for a few days until the floor space is exhausted. Then the furnace is made ready and the work poured.

The small Japanese cupola is not a permanent fixture. It consists simply of two sections of cast iron pipe about 18 inches in diameter and 3 feet long. These pipes are daubed with clay, dried and set one on top of the other on a plate resting on the ground which has also been daubed with clay and dried; the whole operation taking place out in the yard. Coke is used for fuel. The iron for the charge is broken into small pieces and together with the fuel is thrown into the open top of the furnace. There is a tap hole near the bottom on one side but no spout; the ladle is sunk in the ground in front of the tap hole and close to the shell. The blast is supplied by a primitive type of hand bellows. The iron melts slowly and looks quite dull, but as it is high in silicon and phosphorus it is sufficiently fluid to run the work. Japanese workmen are slow and go into infinite detail, but the castings are finished pieces of work when they leave the mold.

There are many interesting sights to be seen in Japan, but taking pictures was forbidden in the war zone and it seemed to be all war zone. One of the boys took some snapshots from the boat and later, after going ashore, he took the films to a shop to have them developed. The shopkeeper reported the matter to the police, the boy was taken before a court and fined 50 yen, which is equivalent to about $25 at normal rate of exchange. His films were confiscated.

The stay in Japan was characterized by several functions of a social nature, prompted by the desire to show a friendly feeling toward the United States. Two days before leaving Nagasaki the contingent was tendered a farewell reception by the city officials and the chamber of commerce. The first part of the reception was held in the largest tea-house in the city and lasted from 2 p. m. until 3:30 p. m. The second part was staged in the Minamiza theater where a performance by Madame Sumako and company, said to be the best in Japan, was witnessed.

Japanese Hospitality

The contingent left Nagasaki by special train, and it must be admitted that both train and service were of the best, arriving at Mogi at 5:15 p. m., the same day. The harbor was crossed by ferry to Shimonosiki, where dinner was served in the Ian-Yo hotel. The dinner was tendered and attended by the chief executives of the imperial government railways. The dining room was beautifully decorated with flowers, mostly cherry blossoms. Speeches and toasts were exchanged and each member of the contingent was presented with a souvenir card of greeting from the Japanese railway men to the Americans. After the dinner the contingent was conducted to the boat, which, amid the greatest excitement and noise, sailed at 9:30 p. m., for Fusan Chosen, Korea, arriving there at 9 a. m. next day. Another special train was provided at this point which carried the contingent to Chan-Chun where connection was made with the Chinese Eastern railway, a branch of Trans-Siberian system. At Chan-Chun everything had to be transferred as the Russian railroad is built

to a wide gage. Harbin, Manchuria, the city where the headquarters of the Chinese Eastern railway is situated, finally was reached at 6:30 p. m., about 57 hours after leaving Nagasaki, Japan.

Most of the railway stock on the Trans-Siberian railroad is imported, but extensive repair shops are maintained at all the divisional points including that at Harbin, which as has already been stated is the junction where the line running to Port Arthur and Dalny joins the main line. Whatever railroad systems and methods the Russian commission studied while in the United States it is quite evident that they did not see any railroad repair shops. The methods and equipment in vogue in the railroad shop in Harbin are archaic, while the workmen move at a pace that is unbelievably slow.

Onon River Bridge Wrecked by the Bolsheviki — Note the Temporary Pontoon Structure at the Left— This is a Typical Siberian Landscape

The foundry building is solid brick, the walls being 30 inches thick at the bottom and ornamented on the outside by an elaborate system of pilasters and copings. The only windows in the building are in the ends and as a result the interior of the building is quite dark. A little additional light is furnished through a few poorly constructed skylights in the roof. The main bay of the shop is equipped with two 10-ton electric traveling cranes and several side wall jib cranes. The latter are never used.

Any casting over a few hundred pounds in weight in this foundry is made in a flask and dried in the oven. All the remainder of the work, no matter how small, is bedded in the floor. The only exceptions to this rule are the oil boxes or journal boxes. These are made in flasks on a machine. The oil boxes in use on the Russian railroads differ materially from those on American roads. They are cast in halves, the joints planed in the machine shop and the two halves afterward bolted together. The only function of the molding machine in making the boxes is to roll the drags over. The inside of the box is made with a dry sand core and the cope is perfectly flat.

No system is observed in making cores as each man makes his own cores in close proximity to his job. Small stock cores are made by boys in any convenient place. The cores are made from a natural loam which does not require any binder. A certain amount of manure is mixed with the loam to give it porosity. The cylindrical cores all are swept on barrels wound with hay rope. All the cores are dried in the same ovens as the molds. The ovens are poorly designed and constructed and as a result are slow dryers.

Cupolas Have Forehearths

Two cupolas are provided for melting the metal, one of three tons, and one of five tons capacity. The metal does not accumulate in the furnace but runs into a receiver as fast as melted. This receiver or forehearth is attached to the front of the cupola, the bottom resting on the floor. It is provided with a slag hole near the top on one side which serves to warn the melter when it is time to tap the metal. The hole also serves to remove most of the slag. The receiver is enclosed but there is a section in front which is detachable and can be removed to fix the bottom every day. After the bottom is made ready and a quantity of wood placed to dry the inside of the vessel, the doorway is daubed with clay and the door clamped tightly in place. The fire which dries the inside of the chamber also dries the mud at the door joint sufficiently hard to prevent the metal from leaking through. A vent pipe, for which there is no obvious reason, is connected to the top of the receiver and is attached higher up to the shell of the furnace. An excellent grade of iron and coke are available, both being imported from European Russia. The iron is high in silicon and phosphorus and it is possible to pour large castings although the metal is melted neither hot nor fast.

A general idea of the operation of the shop may be gained from a study of the following items taken from a typical monthly report of men employed:

IRON FOUNDRY		
Molders	103	
Helpers	29	
Apprentices	23	
Chippers	36	
Cupola men	18	
Brass furnace men	18	
Carpenters	6	
Painters	1	
General labor	43	
		277
BABBITT SHOP		
Mechanics	7	
Helpers	2	
Labor	5	
		14
PATTERN SHOP		
Patternmakers	25	
Helpers	1	
Apprentices	3	
Labor	5	
		34
Total foundry force		325

In addition to the force of 325 men there was one general foreman; one foreman in the iron foundry; one in the brass foundry and one in the pattern shop. The office force included three men and one girl. Most of the workmen were Chinese with a few Russians. Compare the number of men with the output for the month in Russian poods. The pood is 40 Russian

pounds or 36 pounds avoirdupois. The total output for the month of April, 1918, is shown in the following table:

TOTAL OUTPUT FOR THE MONTH OF APRIL TWENTY-THREE WORKING DAYS

Iron Castings	
Poods	Tons
8085	145
Brass Castings	
Poods	Tons
369	6.64
Babbitt Liners	
Poods	Tons
1333	23.99

Analyzing this table we find that the total output of iron, brass and babbitt amounted to 175.63 tons for the month. There were 23 working days in the month and this gives an average of 7.64 tons a day or approximately 10 per cent of what a similar American shop would turn out in the same time.

There is another railroad shop at Nicolsk-Ussurysk, but it is much smaller than the one at Hardin only employing 45 men altogether, all Russians. In August, 1919, this shop turned out 52,740 pounds of iron castings and 4585 pounds of brass, an average of 2397 pounds of iron and 208 pounds of brass a day.

Iron is cheap and the amount of return scrap is so large that no attempt is made to economize. The dump is full of iron which has been wheeled out with the refuse.

The writer sailed from Vladivostok on Oct. 31, 1919, and touching at Manilla, Guam and Honolulu, arrived at San Francisco on Dec. 7, after having been nearly two years in a country which has been maligned as to climate and hampered by tradition for centuries. With its vast natural resources, and favorable geographical position it is only natural that Russia has used every conceivable artifice to add it to her possessions and thus round out her dominions in the Far East.

Questions Effect of Oxygen in Cast Iron

BY J. E. HURST

THE influence of dissolved or occluded gases on the physical properties of metals and alloys and also the exact state of existence of such gases has been given much consideration by metallurgists during the past few years. These phenomena have been considered more fully in reference to steel and the nonferrous metals than in connection with cast iron. In the ordinary practice of melting cast iron in the foundry cupola the metal is brought into intimate contact with several gases in a highly heated state and there is no doubt that a considerable amount of absorbtion or occlusion takes place. Herwig-Stahl und Eisen 1914 states that the gases evolved during the solidification of pig iron after being tapped from the blast furnace contain large quantities of carbon monoxide and hydrogen. He further states that of the different grades of pig iron white irons contain the most hydrogen, while hot-blast grey irons contain the most carbon monoxide.

Professors Carpenter and Rugan in their work upon the growth of cast iron, investigated the gases evolved upon heating samples of gray cast iron in vacuum. In these experiments the specimens were heated gradually in an evacuated porcelain tube. The gases were given off readily as the temperature increased and these were collected on a suitable apparatus. Analyses were made of the gases evolved and in all cases of normal cast irons, it was found that the gases consisted almost entirely of hydrogen and nitrogen, approximately in the proportions of seven of the former to one of the latter. These results are stated to confirm the work of previous investigators. A typical analysis of the gases obtained in these experiments is as follows: Carbon dioxide, none; carbon monoxide, none; oxygen, none; hydrogen, 87.5 per cent; nitrogen, 12.5 per cent.

The possibility of the existence of oxygen in cast iron was briefly discussed in THE FOUNDRY of Dec. 1, in an editorial headed "A Metallurgical Paradox." In these notes it was pointed out that the repeated assertions by different metallurgists that on the one hand the presence of oxygen was beneficial to cast iron and on the other hand that the presence of oxygen was harmful rightly constituted that might be termed a metallurgical paradox."

J. E. Johnson was probably the foremost supporter of the belief that the presence of oxygen in cast iron was distinctly beneficial. In his British patent No. 24,297, dated 1913, Mr. Johnson states that contrary to the usual belief he finds that the desirable qualities possessed by charcoal irons in their qualities of strength, density of grain and chilling properties are due to the presence of oxygen contained by them. The difference in the properties of coke-smelted irons it is thought is due to the difference in the oxygen content. In spite of the definite conclusions made by this worker the evidence for the beneficial effect of oxygen is by no means complete.

Oxygen Not Identified

It would appear that considerable more evidence still remains to be put forward before any definite statement as to the influence of such small quantities of oxygen can be maintained. Before dismissing this aspect of the subject the difficulty of reliably estimating the presence of such small quantities of oxygen should not be neglected.

In the short editorial appearing in THE FOUNDRY, previously mentioned, it was stated that the existence of oxygen in cast iron had not in any way been separately identified under the microscope, and also that the increased mechanical strength of the so-called semi-steel mixtures was attributed by many metallurgists to the presence of oxygen in some form or other. While it is quite correct to say that we are unaware as to the mode or existence of oxygen in cast iron and also whether it is, or is not, possible to separately identify oxygen in cast iron under the microscope, the higher physical test results usually obtained by the addition of steel to foundry mixtures, may be explained otherwise than by the presence of oxygen in the resulting iron.

A view which has always been taken by the author, although unsupported by evidence, can be reasonably suggested at this juncture. It is that the explanation of the physical properties of the cast iron samples containing fairly high percentages of oxygen lies not in the actual presence of oxygen but rather to the fact that the presence of oxygen is an indication of some other condition to which the cast iron has been subjected. A view of this nature might possibly allow of a rational explanation of the seeming metallurgical paradox, in that the cast iron may be submitted to subsequent conditions during the molten stage which either may alter the temperature conditions or which may effect a recarburization without affecting the oxygen content.

New Case Foundries Progressing

Erection of two new foundries is progressing at the plant of the J. I. Case Plow Works Co., Racine, Wis. The gray iron foundry will be 126 x 360 feet, while the malleable plant will be 150 x 300 feet. In addition, the company is erecting a warehouse, 122 x 140 feet. All work is in charge of Flotz & Brand, Conway building, Chicago, architects and engineers, under the supervision of C. D. Bidwell, the company's engineer in charge of maintenance.

THE FOUNDRY DATA SHEET, MARCH 15, 1920
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

FORMULAS FOR THE BRASS FOUNDRYMAN

By P. Ludwik

COMPARATIVE HARDNESS OF COPPER ALLOYS

A careful investigation of the hardness of alloys of copper gives results as follows:

Alloys				Comparative Hardness		
Copper Per Cent	Tin Per Cent	Zinc Per Cent	Lead Per Cent	Chilled Castings	Annealed 3 Hours	Annealing Temperature Degrees Cent.
99.00	1.00	00	00	77.65	77.8	850
96.00	4.00	00	00	99.15	102.7	700
92.00	8.00	00	00	128.0	128.0	700
85.00	15.00	00	00	219.95	181.50	700
80.00	20.00	00	00	285.50	274.00	700
88.00	8.00	00	4.00	121.50	107.50	700
84.00	8.00	00	8.00	119.00	104.00	700
88.00	8.00	4.00	00	102.50	108.00	700
88.00	4.00	8.00	00	104.00	112.50	700
92.00	4.00	4.00	00	147.00	136.00	700
84.00	8.00	8.00	00	156.00	132.50	700
85.00	00	15.00	00	81.00	79.50	900
70.00	00	30.00	00	87.00	89.00	900
65.00	00	35.00	00	92.50	84.50	900
60.00	00	40.00	00	128.50	154.50	800
55.00	00	45.00	00	181.30	183.50	800
66.00	00	30.00	4.00	79.50	79.00	800
62.00	00	30.00	8.00	71.00	71.50	800
66.00	4.00	30.00	00	169.00	138.00	800
62.00	8.00	30.00	00	286.50	243.00	800
58.00	2.00	40.00	00	201.00	199.00	800

The hardness was determined by means of conical impression or *punch* tests of the kind, which in contrast with impression tests usually employed with homogeneous substances, give coefficients of hardness that are independent of the magnitude of the load and of the depth of the impression.

FORMULAS FOR THE BRASS FOUNDRYMAN

By P. Ludwik

COMPARATIVE HARDNESS OF COPPER ALLOYS

Alloys				Comparative Hardness		
Copper Per Cent	Tin Per Cent	Zinc Per Cent	Aluminum Per Cent	Chilled Castings	Annealed 3 Hours	Annealing Temperature Degrees Cent.
99.00	00	00	1.00	75.60	71.25	900
96.00	00	00	4.00	92.50	88.25	900
92.00	00	00	8.00	117.50	119.50	900
90.00	00	00	10.00	202.00	225.00	900
88.00	00	00	12.00	225.50	222.00	900
85.00	00	00	15.00	400.00	400.00	900
92.00	4.00	00	4.00	153.00	136.50	700
88.00	8.00	00	4.00	214.50	182.00	700
88.00	4.00	00	8.00	215.50	212.00	700
84.00	8.00	00	8.00	250.00	244.50	700
58.00	00	40.00	2.00	192.00	187.50	800

COMPARATIVE HARDNESS OF COPPER-NICKEL ALLOYS

Alloys			Comparative Hardness		
Copper Per Cent	Nickel Per Cent	Zinc Per Cent	Chilled Castings	Annealed 3 Hours	Annealing Temperature Degrees Cent.
92.00	8.00	00	67.50	70.00	900
85.00	15.00	00	79.50	85.50	900
70.00	30.00	00	103.00	119.50	900
70.00	15.00	15.00	92.50	96.00	900
55.00	15.00	30.00	93.00	93.50	900
55.00	30.00	15.00	104.00	121.50	900
40.00	30.00	30.00	118.50	119.50	900

COMPARATIVE HARDNESS OF COPPER-MANGANESE-NICKEL ALLOYS

Alloys			Comparative Hardness		
Copper Per Cent	Nickel Per Cent	Manganese Per Cent	Chilled Castings	Annealed 3 Hours	Annealing Temperature Degrees Cent.
92.00	4.00	4.00	85.35	91.50	900
88.00	8.00	4.00	95.50	98.00	900
88.00	4.00	8.00	105.50	105.50	900

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

Microstructure of Malleable Iron

The Old Method of Gaging the Properties of Malleable by the Fracture Is Superseded by Microscopic Examination Which Reveals Details That Indicate the Anneal

BY ENRIQUE TOUCEDA

AS IN the case of steel and the nonferrous alloys in general, the use of the microscope in connection with the manufacture of malleable cast iron has proved of inestimable value to the industry. Had its use not been invoked, many facts either would not be known at all or, if suspected, would be confined to the realms of conjecture. No fairer statement could be made than that the start of real progress in the industry was coincident with the application of metallography to the product, though the full significance of this statement can hardly be appreciated except by those who not only are conversant with conditions at the time referred to, but also with the best present practice.

A few years ago, about the only test made to ascertain the physical properties of the product, except in the case of certain plants, was the bending of a casting to destruction, with the object of not only discovering whether or not the metal was ductile, but for the purpose of inspecting the fracture. The characteristics of the fracture, if correctly interpreted, were known to be of value in locating the trouble in castings that were inferior. In general, it was found that if a casting of medium or heavy section would bend through a wide angle before failure took place, the fracture in the majority of cases would have a black velvety appearance; while if it was held at different angles to the direction of the rays of light, it would show a change of color and an iridescent sheen. But an inferior air-furnace heat or anneal might yield castings, which if thin and consequently largely decarburized, could be bent double on themselves and still not possess the fracture described. If, on the other hand, a casting broke short, its fracture might have one of a great many different colors and structural peculiarities. Depending on the cause of the trouble, such castings might have any of the fracture characteristics, of which the following is but a partial list.

A uniform lusterless black color throughout, except at the decarbonized border.

A uniform, steely appearance throughout, there being quite a variety of fractures under this classification from a very white to a grayish color.

A coarsely granular steely border of varying depth, melting gradually into a core of much darker color.

A dark, mouse-colored sparkling fracture throughout, except where decarburized at surface.

A black sparkling fracture throughout, except at decarburized surface.

A steely border, sometimes very granular and at other times of porcelainic texture of varying depth, having a sharp line of demarcation between it and the core contained within it.

A light or dark dove-colored border of varying depth, having a sharp line of demarcation between it and the core that it surrounds.

A black border surrounding a steely white core, a sharp line of demarcation dividing the two.

Fracture Governed

The foregoing descriptions principally have been given to make clear that it was the invariable custom to inspect carefully the fracture of any broken casting. When the pots were withdrawn from an annealing oven and dumped, various castings were selected for the bending test. If any broke short, the annealer and melter and, perhaps, the superintendent, would try to locate the cause of the trouble. But it was seldom that any two of the men were in accord as to why ductility was lacking or what corrective measure might rectify the condition. The annealer would endeavor to shift the responsibility to the melter, while the latter would complacently state and insist that inasmuch as the hard iron castings were similar in all particulars to previous air-furnace heats that had but recently annealed in a satisfactory manner, it was plain that the trouble was that the castings had been under or over annealed, etc. The consultation would invariably end with nothing definite being determined because the opinion given in each case was unaccompanied by tangible proof. Matters were rendered more uncertain and further complicated because castings from three or four air-furnace heats were annealed together in the same oven. It is impractical to keep the castings from the various heats separated, and on their account the air-furnace heat to which the casting under discussion belonged could not be identified.

The writer has been associated with the manufacture of malleable castings since 1894. In 1904, he became convinced that while practical experience combined with close observation, when accompanied by a good metallurgical foundation, made possible the explanation and elimination of many of the troubles encountered, work's control could never be satisfactorily attained without proper facilities for a study of the structure rather than the fracture of the annealed product. Steps were then taken to secure the best metallographic outfit available and, with the aid of a small electric-resistance annealing furnace and this outfit, more knowledge was obtained in three months than in the previous 10 years. Toward the end of 1911, the writer was engaged by the American Malleable Castings association as its consulting engineer. At that time, few, if any, of the members suspected that the miscroscope could be used as an aid in their work. Today, not only are many of the members equipped with a metallographic outfit, but those who are not make constant use of the one installed in the general laboratories of the association.

As a partial list of fracture characteristics has been given, it is pertinent at this point to make a similar one covering the various structural characteristics that are encountered from time to time. This will necessitate a division of the list into two classes, which must be considered separately for the reason that an anneal may be conducted with most painstaking care and precaution and the castings have an abnormal fracture and structure, in the event that the composition of the hard iron castings are such as to inhibit, in part or almost wholly, the breaking up of the carbides; while on the other hand the hard iron composition may be the most desirable, and an abnormal structure result solely from failure to observe those conditions vital to a correct anneal. If a hard iron casting of correct composition is efficiently

From a paper presented at February meeting of the American Institute of Mining and Metallurgical engineers. The author, Enrique Toucedo, Albany, N. Y., is a consulting engineer.

annealed, its structure will consist of a ground mass of ferrite, throughout which will be quite uniformly distributed a number of fairly well-rounded nodules of free carbon. The fewer and smaller the nodules, the greater will be the ductility.

Irrespective of whether the castings have been placed in an active packing one containing a certain percentage of iron oxide, or in one that is inactive, such as ashes, sand, ground firebrick, etc., there will always be found a surface border in the section that has been almost completely decarburized of a depth that will vary from one that is hardly noticeable to one that will at times exceed 1/16-inch. The writer believes the foregoing covers what can be considered a perfectly normal structure for annealed malleable cast iron, although if a slight outer layer of pearlite is found, surrounding an inner ring or layer of ferrite that is sandwiched between the former and the metal enclosed within these two layers, or if the position of the ferritic and pearlitic layers is reversed, the structure should still be considered normal under the assumption that the pearlitic layer is not high enough in carbon to make machining difficult.

The following is a partial list of structural characteristics of improperly annealed castings of suitable hard iron composition:

A ground mass of ferrite—particles of free carbon distributed quite uniformly throughout—associated with a small amount or, at times, a great abundance of free cementite, indicates that the annealer failed to raise and hold the even to a temperature in excess of the critical, or that the casting was not held long enough above the critical temperature to accomplish completely the breaking up of the carbides.

The presence in the ground mass of considerable pearlite, with rings of ferrite surrounding the particles of free carbon, indicates too quick cooling through the critical range. If these characteristics are confined toard the outer portion of the section, the rate of cooling was but slightly too rapid; if they exist throughout the section the cooling was much too rapid.

A structure normal in all particulars for the presence of an outer rim of pearlite, corresponding to a steel of from 0.60 to 0.85 per cent carbon, contaminated at times by the presence of considerable free cementite, indicates the presence of a carburizing atmosphere in the pot.

A partial list of structural characteristics of properly annealed castings that show abnormal structures due to an incorrect hard iron composition follows:

A fairly uniform ground mass mixture of ferrite and pearlite, throughout which is quite uniformly distributed particles of free carbon, indicates very low silicon or manganese or both.

A ground mass of pearlite throughout which is quite uniformly distributed particles of free carbon indicates very high manganese.

A ground mass mixture of ferrite and pearlite surrounding which is a layer of pearlite and surrounding the latter a ring of decarburized metal, may be caused by a number of conditions.

A ground mass containing more or less primary graphite indicates that the hard iron was contaminated with uncombined carbon.

Value of Microscope

Up to a comparatively few years ago a diagnosis of the fracture was the chief means employed for determining the cause for the superiority or inferiority of the metal in the castings. As for the same hard iron composition, the appearance of the fracture will vary to a considerable extent, the higher the temperature of anneal, the diagnosis were not successful. The writer knows of no metallurgical industry in which the use of the microscope has proved so indispensable as in the manufacture of malleable-iron castings. He is also positive that there are many troubles, the exact cause of which cannot be definitely located without its aid.

It must not be assumed, however, that in all cases dependence on the use of this instrument alone will disclose the true and complete story, for what may be shown by the fracture, the structure, and the chemical composition must, in many instances, be carefully considered too before an accurate diagnosis can be rendered. For example, consider the case in which the hard iron composition of a casting yields, when annealed in accordance with best practice, a perfectly normal structure but an abnormal fracture. Such cases were of very frequent occurrence in the past and, doubtless, are not infrequent today. When certain constituents are present in the iron in certain amounts, they can affect the ductility of the ground mass without having any appreciable effect in preventing the complete graphitization of the carbon during the anneal; and when the ductility of the ferrite is lessened, a more or less granular and grayish or steely fracture will result, for the ferritic grains instead of stretching out in spines will break short, producing facets that will reflect light and yield the appearance indicated. Obviously, then, if a person received a micrograph accompanied by a statement that it was truly typical of the structure and he was requested, from its inspection, to pass upon the physical properties of the casting, he would be forced to confine himself strictly to the general statement that while it could be determined from the micrograph that the anneal had been conducted in accordance with good practice, because graphitization was complete and the grain size good, no prognostication as to physical properties could be vouchsafed unless information concerning the fracture characteristics, or the chemical compostition, or both, was furnished.

On the other hand, quite numerous are the cases in which the microscope plays the dominant role. There are certain defects, the nature of which can be revealed only through metallographic means. The presence of slag, of primary graphite, the conditions that manifest themselves in the fracture arising from an unsuitable pot atmosphere, whether or not an area seen in the fracture, through contrast, to be different in appearance from the rest of the section is the result of segregation, or is due to some other cause, such as a slight shrink, etc., are impossible of identification in any manner known to the writer other than through microscopic investigation. In the opinion of the writer the use of the microscope in the malleable industry is mandatory.

Electrical Melting of Alloys—II

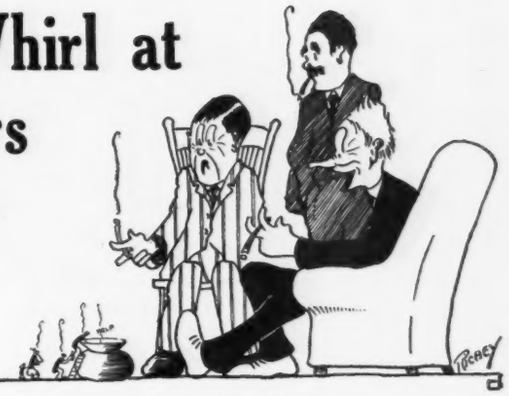
(*Concluded from page* 231)

be put into the design. No successful electric furnace has sprung full-blown from the brain of its maker. All have had to go through a long and expensive period of development, and have had to be refined and improved by years of experimental test and commercial use. Those that have not gone through this period may be good investments for the philanthropist or the speculator, for the ultimate furnace has not yet been evolved and any new scheme may contain its germ. However, for the firm that wants to put in an electric furnace and have it work from the start, a furnace unseasoned by long experimental trial and preferably by commercial operation in many other plants, is a good one to avoid.

The price of a furnace should, and in some cases does, include the services of some one on the furnace-builder's staff who not only knows that electric furnace, but also enough about brass melting to fit the furnace into the operation of the plant that has purchased it, with the least delay. Such service is valuable.

Bill Takes a Whirl at Propellers

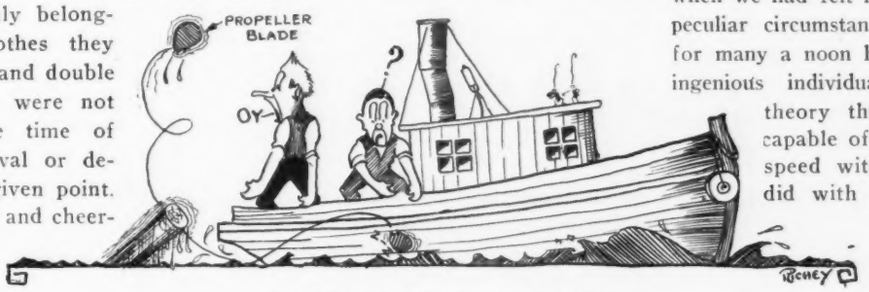
BY PAT. DWYER



AN OLD friend of Bill's, from the Coast blew into town the other day. He did not come for the express purpose of permitting the light of his countenance to shine on Bill, but he was not here long before he found the old boy. Since I was a mutual friend, the two of them came over to my house one night. They had been intimate in their young days; but their last journey together had been when they hit the overland trail to the coast many years ago. They were in no hurry at that time. They travelled by easy stages, mostly on freight trains, stopping off at many towns on the way, sometimes voluntarily and at others, by request. They made no attempt to travel in a straight line and, since their only belongings were the clothes they wore and a trowel and double ender apiece, they were not worried about the time of their probable arrival or departure from any given point. They drifted lightly and cheerfully from town to town but always in a general westerly direction. They lingered awhile in Omaha, Salt Lake City, Denver, Pueblo, Monterey, Los Angeles and San Francisco. After a few months sojourn in the latter town the migratory germ began to show signs of rejuvenation in Bill, but when he proposed to his friend that they go down to the freight yard and pick out a car ticketed for over the mountains he was shocked to find that his friend had decided to stay in 'Frisco indefinitely. Bill expressed his opinion on this resolve, volubly, forcibly, pointedly and altogether in a way which reflected credit on his foundry training. However, his friend was obdurate and Bill made the trip back to the east alone.

Now this was the first time they had met since the old days and naturally there was no lack of conversational topics, but with that strange perversity of molders the world over, we soon drifted into a discussion on foundry methods with particular reference to molding propeller wheels.

"There are many ways of making propeller wheels," said Bill. "It is largely an individual proposition because they are never made on a quantity basis like stoves or automobile castings. Nearly every designer has a theory of his own for the construction of wheels. The rake, pitch, diameter and width of the blades furnish an endless subject for discussion, not only among designers but among marine engineers as well. There never was an engineer yet, no matter whether he was on a tupenny-ha' penny tug boat or on a 12,000-ton tramp but was willing to wager that if the owners would listen to him, he could design and install a propeller on the old tub that would increase her speed by a couple of knots at the least and reduce his coal consumption in like proportion. I have made enough of them and seen enough of them in use to entitle me to a little more than a mere bowing acquaintance, but as to advancing an opinion as to which is the best type, that is beyond me.

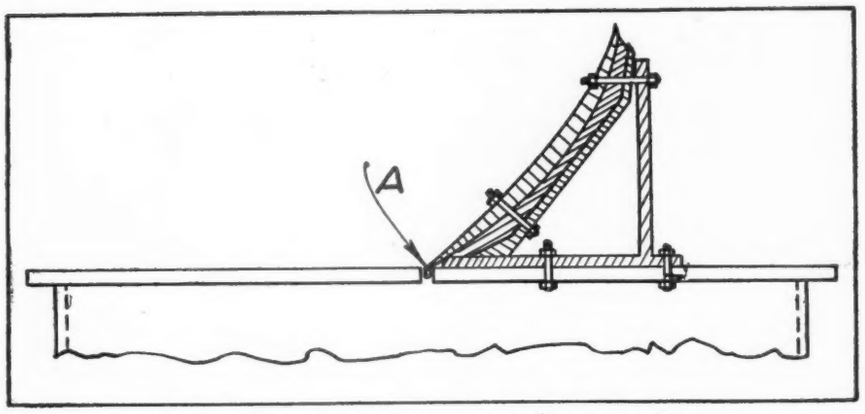


ALL DOWN BUT ONE—SET 'EM UP AGAIN

"Do you remember the tug ELSIE, the firm built when you and I were serving our time? There was something happened on her trial trip which made me doubt the omnipotent wisdom of designers. You remember when she was launched, the firm granted us all a half holiday and invited us to go for a spin on her trial trip. She was equipped with a three-bladed wheel and ran down the river for a distance of about 10 miles in a little less than an hour. Shortly after turning to come back we all distinctly felt a shock and it was discovered that the propeller wheel had struck a half submerged log. The accident did not seem to affect her in any way and the engine, which in this instance was a beautiful little triple expansion model, was not stopped. We made the return trip in less than an hour and this was accounted for among the knowing ones by the explanation that the engine had lost its initial stiffness and now was running *sweetly*.

"After tying up to the dock an examination was made and it was discovered that two wings of the propeller had been broken off at the time when we had felt her hit the log. This peculiar circumstance furnished a topic for many a noon hour discussion. One ingenious individual persisted in the theory that if the boat was capable of developing as much speed with one blade as she did with three, it was quite clear that the blades were a detriment and by a simple system of reduction he was willing to prove to any person interested that she could make even better speed if all the wings had been broken off. He was strong on logic and figures and could prove his theory by a string of figures on the core oven door, but some how I never felt convinced. There must be a flaw in the theory or some bird would have built a propeller without wings before now.

"You would think that after the gallant performance of that lone wing that the company would hesitate to interfere with it, on the principle of 'Woodman spare that tree.' However, subsequent events only confirmed the old saying that 'Corporations have no souls.' They pulled the gallant old stump off her, scrapped it and put on a new wheel. In fact there were three or four wheels tried at various times,



DEVICE FOR ASSURING ACCURACY WHEN RAMMING THE BLADES

each one a little different in design from the other, but I never heard that any of them increased her speed to any appreciable extent.

"A competent foreman had charge of that old shop and he was fortunate in having several highly skilled men working for him. I did not realize fully at the time but I have moved around some since and I have a proper feeling of respect for the mechanical ability of the men who could turn out the work they did with the primitive rigging in vogue at that time. The foreman was not exactly slow but he was certainly sure. He believed in providing a liberal safety factor in all of his operations. I have seen him hold the wind back an hour or even two hours sometimes to allow his star men time to finish a job rather than send men who were not reckoned to be in the A 1 class to give them a hand.

"How we youngsters loved that kind of thing! At that period of life the days work was only an incident, the really important events only occurred after we had rushed home, changed our clothes, bolted some supper and hurried down town to join the gang.

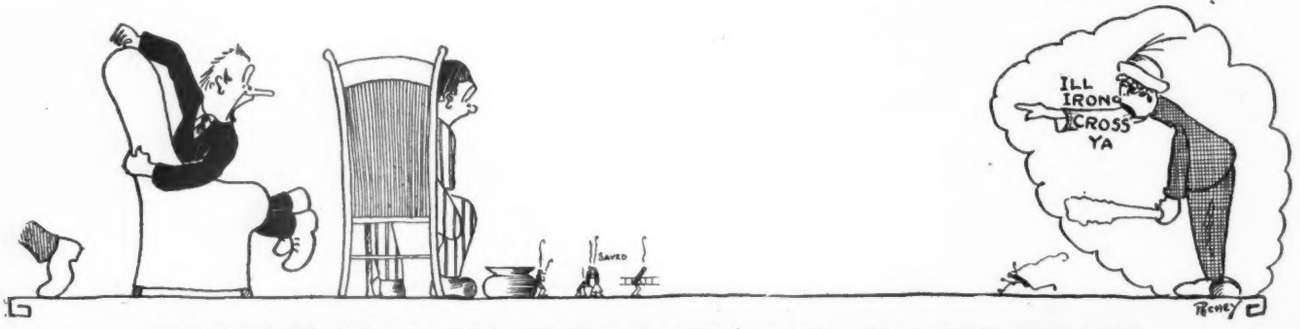
"Most of the big work was made in a pit under the sweep of a hand-power jib crane and when we saw them hooking a big cope with the intention of closing it, at a time when, under ordinary circumstances the wind should be going on, our hopes for the nights fun would go glimmering. The cope would first be tried on, then off again. It always was ten chances to one that some adjustment of cores or something else would be necessary. After the adjustment was made the cope would be tried on and off again in the most deliberate manner. When it finally was lowered off for the last time, it meant at least another hour before the binders were all set, the bolts tightened and the runner and basin made up. I have worked in other shops since and learned many things. I have even arrived at the foreman degree and I have always figured the time it would require to fill the ladle or ladles and put the wind on at a time to have the metal ready to pour by the time the mold was ready to receive it. That method did not obtain in the old days. The wind would not be put on until the last bolt was tightened and the last little ball of clay put in the risers. Then the men would sit around for an hour or more while the iron was melting. The system had its advantages, but I objected to it in the old days because it interfered with my nights fun and I objected to it in later years because it ran up the operating cost.

"We made several propellers there every year, some had the wings and hubs cast separately and others were cast solid, that is with the wings and hub forming one casting. For molding wheels of the latter type the pattern-maker would prepare a single blade attached to a hub. We would dig a hole in the foundry floor and find a spindle seat which was left there permanently. The spindle would be set up, a level bed swept at the approximate depth of the lower edge of the blades. A mark would be scribed on this bed at a suitable distance from the center, and on this circle spikes would be inserted at the three or four points necessary to locate the wings. One wing would then be rammed up and a parting made and then three or four copes would have to be built, using the joint of the mold as a guide to secure the proper angle to bevel the joint of the flask. Occasionally a set of copes already in existence would be found to fit, but as I said before owing to the changes constantly being made in the patterns it nearly always was necessry to fit up new copes for every job.

"I have seen many propellers made since that time, some from patterns and some off old castings and some with nothing but a few sweeps. I have seen them molded in green sand, dry sand, and loam, and in iron, brass and steel but the best rig I ever saw was in a certain shop I blew into one time when the blowing was good. This rig was designed primarily to expedite molding a large number of duplicate propellers; but it would serve equally well on a wide variety of sizes.

"A propeller is only a large screw, with the blades corresponding to the threads. Its efficiency depends in a large measure on the accurate location of the blades in relation to each other. With a narrow blade and a good stiff pattern there is not much danger of distortion; but some blades are quite long and wide and it is difficult to prevent them from springing while packing the sand under them.

"The device constructed for insuring accuracy in setting the blades was a casting shaped like a double flanged pulley with a hub and set of arms. The hub was bored out to act as a spindle seat and the top flange was machined to a true plane at right angles to the bore of the hub. A number of holes were drilled through the top flange at equal intervals; four to locate the blades, four more to receive anchor bolts for holding down the copes and



ILLUSTRATING THE POWER OF MENTAL SUGGESTION—BILL FEELS THE URGE CALLING HIM TO OTHER SCENES

the others for bolting the upright frames. When it was ready a hole was dug in the foundry floor, the casting, or more properly speaking, the jig was lowered into it and blocked up level at a sufficient depth to bring the top of the propeller blades flush with the foundry floor. It was then rammed full of sand, a spindle set, and a collar slipped over the spindle and attached by a set-screw at the proper point to engage and support the hub of the pattern. The pattern which consisted of a hub bored out to fit the spindle snugly, and one wing, was located by lowering it over the spindle until the core print touched the collar and the edge of the blade rested on the flange of the jig described. A dowel pin was attached to the lower edge of the blade and this fitted into one of the holes in the flange (shown at *A* in the illustration.)

"The hub being located definitely, also the bottom edge of the blade, it was necessary only to support the wide expanse of the blade to prevent distortion while ramming sand under and against the lower side. This was accomplished by constructing a set of four triangular frames and setting one up in each of the bodies of sand corresponding to the drag. A strong batten was attached to the under side of the pattern. Two ¾-inch holes were bored through both pattern and batten corresponding to two similar holes bored through one side of each of the four triangular frames. After the pattern had been located bolts were passed through the holes, holding the pattern and frame together. Then the base of the frame was bolted to the flange of the foundation ring. Sand was rammed against the pattern and a parting made after which the cope was rammed in the usual way and taken off. The nuts on the bolts holding the pattern in place were removed, the bolts backed into the sand, and the pattern drawn up far enough to clear, then lowered into position for the next wing. The cavity left by the batten was filled with sand and slicked to conform to the shape of the mold. The remaining three wings were treated in a similar manner. When all four wings were finished and the mold assembled an iron cross was set on top, which with four bolts served to bind the mold together for casting."

"Now talking about iron crosses," said Bill, "reminds me of a German who worked alongside me in the Mesta one time, he—"

"I think it is about time we were hitting the trail," said his friend, "or the Missis will be hanging an iron cross on you."

Excess Metal on Locomotive Frames

It is well known that cast steel locomotive engine frames and other castings of a similar character vary considerably from the sizes shown on the drawing therefore ample allowance must be provided on the pattern so that the castings can be finished to size. This factor of providing extra metal to make up for the unequal contraction also must be taken into consideration when estimating the cost. The finish allowance generally used on locomotive engine frames of cast steel is shown in the accompanying illustration at the bottom of this page.

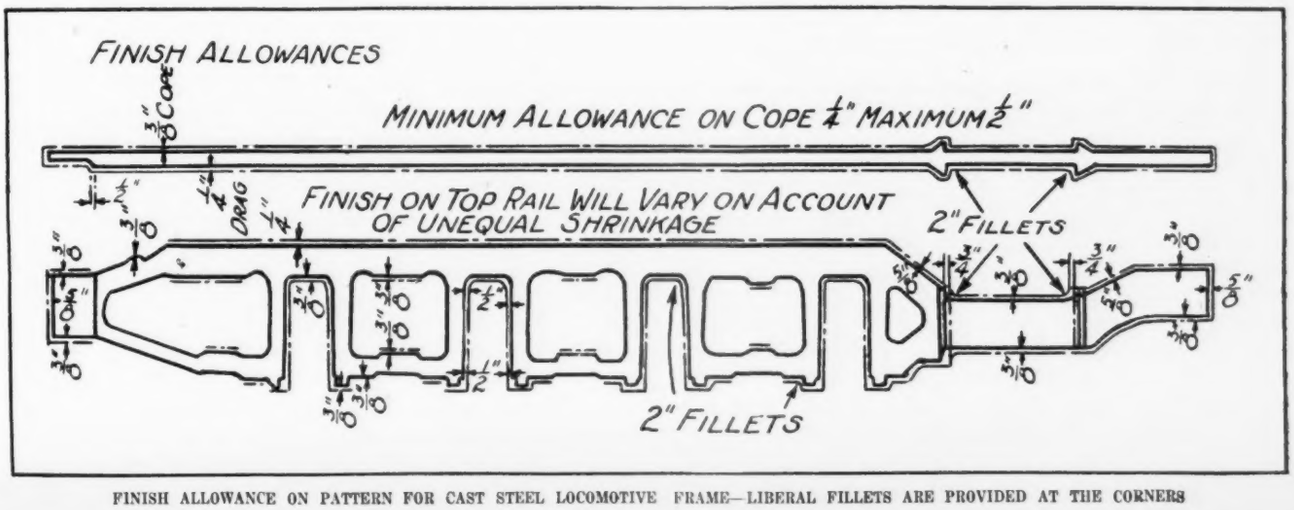
Fillets and rounded corners are among the precautions taken to prevent steel castings from cracking or tearing in the mold between the time of pouring and the time of cooling. The most elaborate precautions taken in preparing the mold will not prevent checks, cracks or tears caused by steel of an improper composition but they will assist materially in producing whole, sound castings when the steel has the proper physical and chemical properties for the purpose intended.

Cast steel contracts approximately $\frac{3}{16}$-inch to the foot. This means that a frame 30 feet long would require a pattern and mold 30 feet 5⅝ inches long. Every casting contracts from both ends toward the middle and it is a problem at times to figure in advance the proportion of contraction to allow at various points between the ends where the maximum contraction takes place and the center where there is practically none noted.

The shape of the pattern, the thickness of metal section at various places, the amount of resistance offered by the sand at different points either in the shape of cores or projecting bodies in the mold, all have a more or less direct bearing on the amount of contraction to be allowed for in designing the casting. The first casting made from any pattern is an experiment, after it has cooled completely and no further contraction is possible, it is carefully checked for size and dimensions against the pattern. Valuable data are secured in this way which serve as a guide in altering the existing pattern if necessary and in designing new patterns of a similar character.

The Pattern Engineering Co., formerly at 1958 W. 48th St., has removed to 4009 Detroit avenue, Cleveland, where a new building has been constructed. The company shortly will incorporate for $25,000 with R. A. Reicht, president and V. L. Wakefield, secretary-treasurer.

Alley & Page have been made selling agents in New England, New York and New Jersey for chilled sandblasting shot manufactured by Harrison Bros., Inc., Amesbury, Mass.


FINISH ALLOWANCES
MINIMUM ALLOWANCE ON COPE ¼" MAXIMUM ½"
FINISH ON TOP RAIL WILL VARY ON ACCOUNT OF UNEQUAL SHRINKAGE
2" FILLETS
2" FILLETS

FINISH ALLOWANCE ON PATTERN FOR CAST STEEL LOCOMOTIVE FRAME—LIBERAL FILLETS ARE PROVIDED AT THE CORNERS

Patterns for Jobbing Pipe Work - I

By the Use of Models Kept in Stock, the Flanges May Be Varied, Tees Arranged, Bends Provided and Branch and Curved Pipes May Be Made

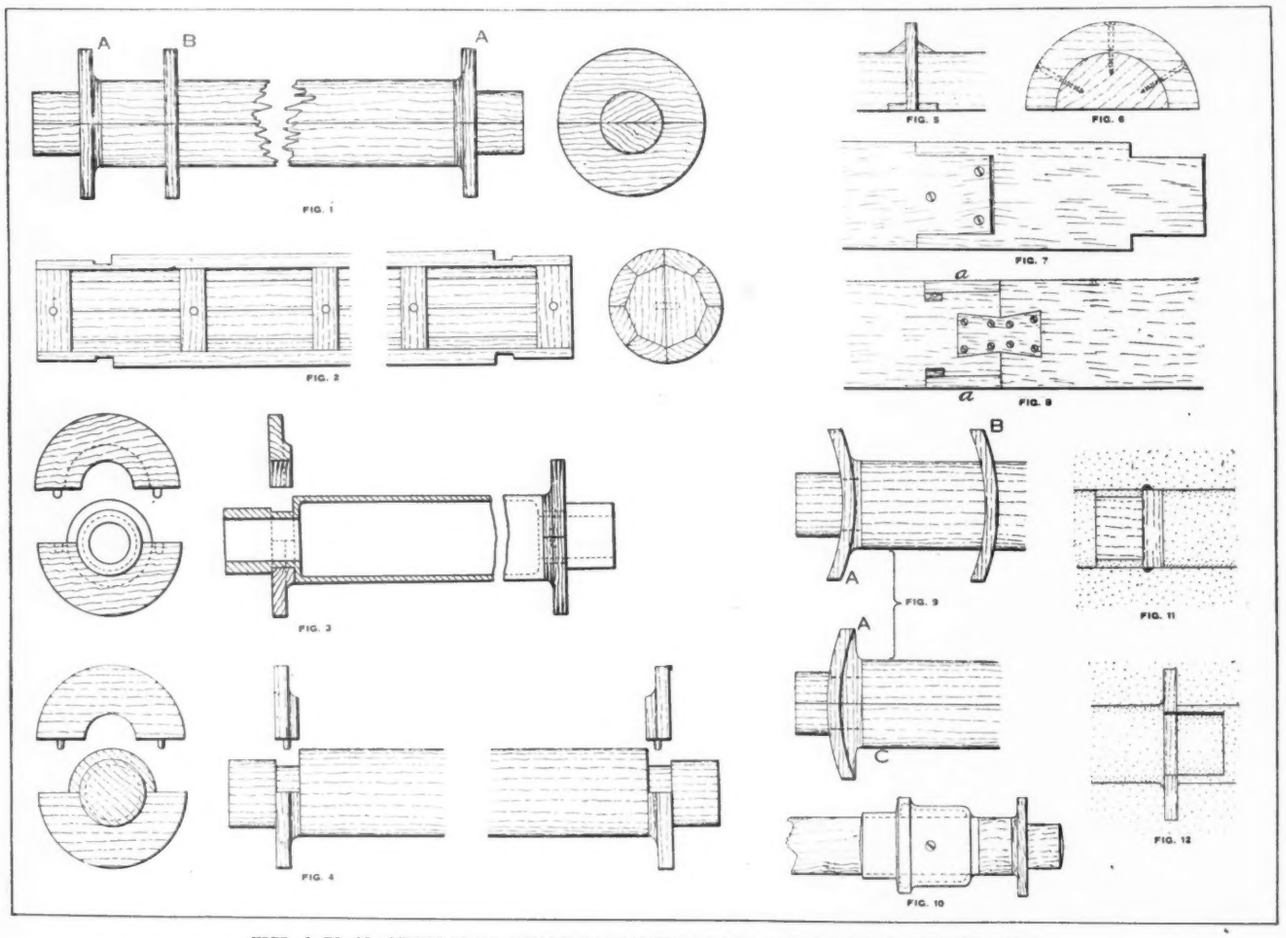
BY JOSEPH HORNER

JOBBING pipe work is a specialty in a good many shops. The writer was engaged extensively in this line of work in England at one period and, therefore, presents a series of sketches and descriptions relating thereto which may be of service to others.

Pipe work comprises straight lengths of pipe, bends, tees, etc., each being flanged, or provided with spigot and socket ends. The castings usually are of parallel bore throughout, but sometimes they are tapered for reducing purposes. In addition to the foregoing there are various subsidiary fittings, such as socket pieces, flanged or spigoted thimbles and stops. Bends and tees are made to various angles, and of numerous and special shapes. Ordinary dimensions of pipe bores range from 24 to 48 inches. Entirely different methods are pursued in making castings of the smaller as compared with those of larger dimensions and this practice varies also with the number of castings required.

Every shop engaged in jobbing pipe work has a stock of standardized patterns of straight pipes, bends and sundry fittings and adjuncts. The pipes are made and stored in bore diameters ranging from 2 to 12 inches. They are kept in larger dimensions if there is a frequent demand for larger sizes. However, anything over 10 or 12 inches, that is only required occasionally, is swept in loam. The bores, in inches, will run from 2 to 10 inches. The thicknesses of metal will vary, but 2 to 4-inch pipes generally have ⅜-inch metal; 5 to 8-inch, ½-inch metal, and 9 and 10-inch, ⅝ or ⅝-inch metal. But it is often necessary to vary the thicknesses in the same bore, one being heavier than the standard, because some castings are subjected to higher pressures than others. Therefore, is is advisable to make extra heavy patterns for 4-inch pipe with ½-inch metal; 6, 7 and 8-inch bore with ⅝-inch metal and 9 and 10-inch with ¾-inch metal. When this is not done a frequent practice is to place a core, ⅛ or ¼-inch smaller than standard in a given pipe, increasing the thickness of metal in this way provided the diminution of bore is not objectionable. Pipe patterns are made to standard lengths, that is, 9 feet in all sizes, except the 2-inch bore which is 6 feet long.

A standard pipe pattern with a 3 or 4-inch bore is shown in Fig. 1. The ends are always grooved, as illustrated, for the insertion of the flanges,



FIGS. 1 TO 12—METHODS OF ATTACHING FLANGES TO PIPE PATTERNS FOR JOBBING WORK

AA, which are thicknessed and bored to fit just hand-tight in the groove, so that it is unnecessary to screw them in place. There are two reasons for adopting this method of fitting. One is that the truth of the flanges is maintained perfectly by the grooves; the other is that alterations in the sizes of flanges for special pipes can be made if desired. Since body flanges *B*, also can be substituted, the pipe, although standard, is readily used for casting other lengths. Socket and spigot fittings can be substituted for flanges, or a flange and faucet. Such modifications frequently are demanded and they could not be made in an absolutely standard pattern kept only for repetitive molding.

The pattern, Fig. 1, is shown jointed and dowelled in two pieces of solid material, that is, not lagged-up. This is the usual practice up to about 5 inches, but above that the patterns are lagged, as shown in Fig. 2.

Some patterns, especially those in regular use, are unjointed and made in metal, Fig. 3, or in wood, unjointed, Fig. 4. Provided with special bottom boards and flasks, it is advisable not to joint these patterns, because, when solid, they preserve their truth longer. In the case of Figs. 1 and 2, there is always risk of the joint faces becoming more or less convex, concave, or winding, as a result of the frequent swabbing of the joints. But this drawback is compensated for in jobbing work, because of the facility with which the joint faces afford the marking-off of centers and distances for the attachment of flanges, branches, etc.

Cutting is Avoided

When patterns have to be altered it is always understood that no cutting is permissible. It sometimes happens that some cutting is unavoidable, but for this purpose sundry odd pieces of pipe lengths are kept in stock, to be used as required. Standard lengths, such as Figs. 1 and 2, are altered in the following manner: In dimensions of flanges, in length of pipe, in the forms of flanges, in the substitution of sockets and spigots and in the fitting of branch pieces.

Patterns with flanges of standard dimensions are so constructed that the flanges may be replaced by others in the same grooves, larger, or smaller, for special jobs, the total or over-all standard length remaining the same.

When the length of pipe is altered, it generally is to something less than the standard length. Then a body flange is fitted at the length required. Fig. 1, *B*, is a flange bored to fit the body of the pattern along which it can be adjusted and fixed in any position, either by means of locating brackets, Fig. 5, which are nailed to the body, and the impressions of which are stopped-up subsequently in the mold, or with screws, inserted as in Fig. 6. No radius, as a rule, is turned on a body flange.

Occasionally, when a piece of pipe has to be cast longer than the standard, a piece of the required extra length is attached to one end by being cut to fit over the print, Fig. 7, or is attached by means of a dovetail, as shown in Fig. 8. There is no objection to cutting a dovetailed recess on the joint faces of a print in the manner shown. Strips, *a*, *a*, are nailed around the print to increase it to the size of the body. Sometimes these are omitted, and then the molder has to scrape out the sand, which can be done easily with the guidance afforded by the body mold. A body flange screwed on as at *B*, Fig. 1, coincides with the increased length of pipe required.

Changing the Forms of Flanges

Considering the third alteration, namely, that of the forms of flanges, this chiefly relates to pipes which are curved to fit against other pipes, or cylindrical vessels. They are termed bent flanges. As they are generally body flanges, they are rather awkward to fit. Bent flanges are more readily made accurately when they are fitted into a turned groove as at *A*, Fig. 9, since the shoulders of the groove coerce the flange. When put on the body as at *B*, the result depends upon the fitting of the brackets of wood nailed to the body of the pipe, as in Fig. 5, or attached with screws, as in Fig. 6. If the flanges become shifted out of their proper place, the result is a bad jointing-up of the casting.

The method of jointing these bent flanges depends upon the direction in which the pipe has stands when seated. In some cases this makes no difference, but frequently the position of a branch or offset renders necessary a jointing of a pattern flange in one particular plane. That in Fig. 9 is better adapted for molding when the joint is located as shown at *C*, Fig. 9, since the flanges can be permanently screwed to the pipe and are not removed while ramming and drawing the pattern. If the joint is in the plane at right angles, the flange halves must be left in the mold when drawing the pipe pattern and would have to be withdrawn separately in a curved direction.

Square flanges have to be used occasionally on pipes. These are better jointed diagonally to facilitate delivery. But as this may trouble the molder because the standard flasks are too narrow to admit the flanges, it is advisable to ascertain if this is the case, since the flanges may have to be altered and cut parallel with the edges.

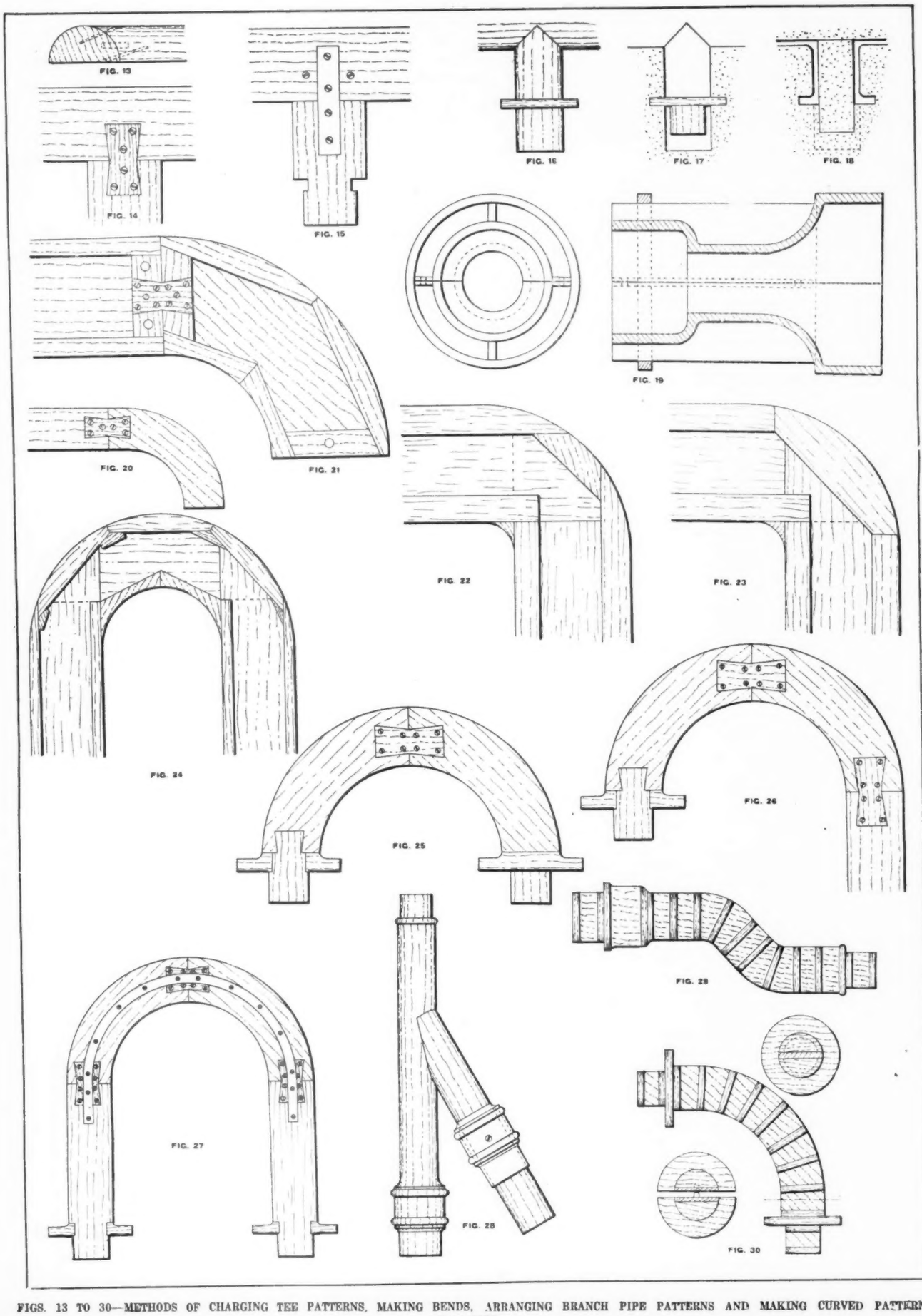
Fitting sockets and spigots is accomplished either by altering the standard lengths of flanged pipes, or a special set of patterns is kept for the purpose. Many socketed pipes, like flanged pipes, are shorter than standard, and odd lengths are kept for the purpose of making these. When long flanged pipes are used for socketed castings, the flanges are removed and a socket of wood or of iron is fitted over the body, the spigot being formed by a strip of lead bent around. Wooden sockets are not of much use, because they get out of truth and become broken. The socket portion includes its print. It can be adjusted and screwed in any position required on the body of the pipe. An iron socket, shown in Fig. 10, is better than one of wood. It is lightened-out, forming a mere shell, and a single screw retains each half in position.

A spigot beading of lead is bent around and nailed. When put on the body away from the termination of the pattern, a stop-off piece is involved, as shown in Fig. 11, which illustrates the stop-off piece in the mold and the print impression made good. Fig. 12 shows a stop-off piece in the mold such as would be used for the flange, *B*, Fig. 1. Two methods are employed, one, the usual in which the flange carries a print, as in Fig. 11, and the other, the alternative, shown in Fig. 12. This involves cutting a hole in the stop-off flange the size of the print, which serves as a guide to the molder's trowel in scooping out the print impression.

Tees Not Altered Much

Standard tees are flanged or socketed, like the pipes. The method of construction admits of no important alterations. The flanges are fitted into grooves and the sockets are turned in the solid. The branches can be adjusted along the main pipe portion, or branches longer or shorter can be substituted. But little more can be done. If, therefore, specially-proportioned tees are required of unusual lengths, or with branches set at an angle, or with diminishing sections, odd lengths of pipe are pressed into service and body flanges and iron sockets are attached as required.

Three methods of fitting branches are shown in Figs. 13 to 15. The first involves the least trouble, but is not secure enough for constant service. The branch piece, abutted with the gouge, is pinned and nailed or



FIGS. 13 TO 30—METHODS OF CHARGING TEE PATTERNS, MAKING BENDS, ARRANGING BRANCH PIPE PATTERNS AND MAKING CURVED PATTERNS FOR PIPES

screwed. In Fig. 14 it is more securely held with a dovetail. In Fig. 15 it is fastened with an iron plate recessed into the pattern and two screws.

As these branch pieces are odd lengths used for longer and shorter castings, stopping-off is generally necessary, using body flanges. Fig. 16 shows a branch with its body flange, Fig. 17 its stop-off piece inserted in the mold with its print—the alternative method to Fig. 12, already explained—and Fig. 18 shows the core inserted.

The marking-out and correct setting of body flanges is done in the joint faces of pipe patterns. On every piece of pattern, a line is scribed down the center in the joint, and this is used to measure from to the flange or socket faces on branches. To set a flange square, a try square is worked from one edge, or from a joint face. If flanges are set at a bevel, the bevel is employed similarly to the square.

Cores for branch pipes generally should be made bell-mouthed. For standard tee pipes, standard half core boxes are kept in stock, but when branches are fitted for jobbing work, the bell-mouthing is frequently omitted. If necessary, the abutting end of the swept-up core is left large, to be filed and rubbed to the radii when dried. Fig. 19 shows a standard iron box which includes the sand for the bell-mouthing for a socketed branch.

Bend Patterns Considered

Standard bend patterns are made in flanged and socket and spigot forms, to fit the standard straight lengths of pipe. But there are differences in the arcs of the curves, as quarter bends, eighth bends, and sixteenth bends, respectively, the terms designating the length of the arc which each makes in proportion to the circle. These patterns are not cut in order to supply jobbing pipes. Other bends also are kept for these purposes, some being made up with flanges, or sockets, or with short lengths of straight pipe to suit any required connections. They coincide as regards bore and thickness of metal with the standard bends, and are made of various radii and lengths, and with dovetails. Differences in the degrees of curvature of bends of the same bore are necessary to permit either the laying of pipes to clear obstructions, or in the case of the flatter bends to allow of a free flow of liquid, or of the setting of the straight connections at obtuse angles.

Fig. 20 illustrates the fitting of a bend to a straight piece of pipe by means of dovetails. This is the method almost invariably adopted. The dovetail is simple, easily fitted, and detached, maintains a close end contact of the joints and does not interfere with or injure the outside of the pattern. The pieces which are recessed range from ½ to 1 inch thick, depending on the diameter of the pipe. Large bends are fitted similarly, Fig. 21, this showing a lagged pipe, and a bend blocked-up for the purpose of preventing its distortion as a result of the shrinkage of solid material in large masses. Other methods of building-up are shown in Figs. 22 to 24, the patterns being open in the joint faces.

In Figs. 25 to 27 other joints in bends are shown. In making the bends the four quadrants are turned on a face plate and the four pieces make one semi-circle in the completed jointed pattern. They are united with dovetails to each other, and glued and united similarly to straight pipe as in Fig. 26. Fig. 25 shows two alternatives in fitting flanges and prints. On the right hand side the solid flange is screwed to the bend and the print to the flange. At the left the print is fitted with a dovetail and a turned shoulder receives the flange. Both print and flange are thus centered and are not so liable to become displaced with rough usage as when they simply abut. In Fig. 26 the method is repeated. Fig. 27 shows an arched bend made to be cast in large numbers. Dovetails are used to unite the bends to each other and to the straight lengths of pipe, but in addition a strap of wrought iron, about ¼-inch thick, is bent and recessed into the joint face, and screwed, so that nothing can shift with rapping. In Fig. 28 a branch is shown fitted at an angle to a hot water pipe. The main pipe has a wood socket turned solidly on it and the branch has a standard iron socket attached with screws.

There is an alternative method of making patterns for bend pipes of unusual shapes when only one or two castings are required. Loam patterns are objectionable on account of their disproportionate cost, their weight, and in some cases because they cannot be tried in place, which is necessary in the making of some pipe connections. Here the template often is fitted before making a loam pattern, but it also may be used as the basis of the actual pipe pattern. When a template has been fitted into the place which the pipe has to occupy, the positions and diameters of flanges are represented by rough disks of wood attached by means of brackets to the plated portion. This may be prepared as a pattern, or a pattern can be made from it with allowance for shrinkage in length, blocking-up for the body, and putting on prints. Fig. 29 shows such a pattern made of a plate of wood, having blocks nailed on it at intervals to form the circular section. The blocks are cut with the band saw. The inter-spaces are filled with hard-rammed sand, sleeked around to the same section. A good mold can be made from such a pattern. Pipes of all shapes and dimensions, small and large, socketed and flanged, with and without branches are made in this way. Fig. 30 is another example, namely that for a plain bend. The sections show the methods of construction.

Mine Car Wheel Cores

By Pat Dwyer

Question.—We should like to get a core sand mixture for mine car wheels that would shake loose and run out of the castings while they are in the tumbling barrel. The oil chamber is connected to the center core through three small openings and all the sand from the chamber core has to be removed through these openings. We are using an oil sand mixture at present but it does not run freely from the casting.

Answer.—It is not so much a matter of a mixture as it is of the way the cores are dried. The mixture has an effect only if too great an amount of binder is used, when some of it will remain in an unburned state and hold the sand in the casting in a solid lump. Only enough binder should be used to enable the core to withstand handling and the pressure of the molten iron. The cores must be dried in the oven thoroughly and until the skin is on the point of scorching.

Coremakers as a rule are inclined to use too much binder in the sand "to be on the safe side." Of course, the amount that should be used will vary with the size and shape of the cores and also with the kind of sand that is available. In your case, a medium coarse sharp sand, known in some parts of the country as sea sand, beach sand, river sand or bank sand, mixed with oil in the proportion of one part of oil to 40 parts of sand should make a satisfactory core. You may have to increase or decrease this proportion a little, a matter which may easily be determined by making a few sample cores and trying them. No matter what mixture is used the cores must be dried to the point of burning.

The Braddock Mfg. Co., Braddock, Pa., has sold its Braddock works to the Wilson-Snyder Mfg. Co., Pittsburgh, manufacturer of pumps and equipment.

THE FOUNDRY

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Opportunity Awaits Steel Foundrymen

DURING the entire period of the war the steel castings industry was taxed to capacity. The great multiplicity of peace time uses to which steel castings are adapted was augmented by the millions of new parts for ships, locomotives, cars, trucks, gun carriages, tanks and projectiles. Steel foundries met the emergency. Manufacturing capacity was increased to meet the need. Shop practice was revamped and metallurgy pointed the way to the attainment of quality to meet rigid specifications. The entire steel castings industry benefited immeasurably and assumed a place never before attained, in the 40 or 50 years which cover the span of steel casting practice.

Following the war came a slump. The abnormal demand collapsed. Peace brought a slackening even over the normal prewar requirements. The industry as a whole found less than 50 per cent of its capacity was required to meet the need for steel castings. This condition continued with only a minor increase over the period during which gray-iron and malleable plants which had been struck by the same lull directly after the armistice, again regained headway and met such a steady acceleration in demand for their products that today practically all are engaged to capacity.

The lot of the steel castings maker in general has not been happy during the past eight months, although a few exceptions have existed. Some plants, which had grown into lines contributing to the manufacture of automobiles, trucks or tractors, and those supplying a few special machinery fields were enabled to again reach production carried on the wave which swept the automotive industries into prosperity. However, it is doubtful if even these fortunate steel shops served to bring the general average of steel castings production much over 60 or 70 per cent of normal.

A new situation now has developed which promises better times for steel foundries. With the abnormal demand for all classes of machine parts, barriers which have prevented the active competition of steel castings with other products, notably forgings, have been leveled. The improvement in the physical characteristics of steel castings fostered by the war, has served to enable steel foundrymen to make gears, axles, housings and sundry machine parts which compare favorably in quality with the best forged products. Intelligent heat treatment has helped the case of the steel casting, while improvement in foundry practice has enabled foundrymen to produce castings which in appearance and machining qualities are fully equal to die-formed drop forgings. Other fields which have been held without question promise much for the steel foundrymen who will offer competition at this time.

Price considerations at present favor the casting maker. While the growing demand for semifinished steel coupled with restricted steel plant production during the past few months has forced prices of forgings steadily higher, steel foundry raw materials have not advanced in proportion. True, open-hearth or converter plants have to pay more for pig iron, and scrap is higher, but the increase in price has been proportionately less and the supply of these materials is more ample. Further, the labor cost which has increased steadily in all industries, has had a strong influence upon the price of forgings at every stage from raw iron to finished products. These considerations mark a larger field for the steel foundryman.

Trade Outlook in the Foundry Industry

HARRASSING difficulties in obtaining materials continue to beset foundrymen in general. This condition, which by no means is confined to the foundry industry, but seems general in all lines, is manifested through difficulty in securing deliveries on metal and fuel. Producers of iron and coke are far behind on their manufacturing schedules, and restricted traffic due both to car shortage and transportation difficulties incident to an unusually severe winter have brought about an actual shortage in many localities.

Seasonal Troubles

Heavy storms through the latter part of February brought many plants throughout the East and central states to the verge of a famine in both iron and coke. In New England, ice and snow tied up traffic to such an extent that foundries which already had used up their yard stocks were obliged to close down to await more iron. Through Pennsylvania, Ohio and Indiana, delayed delivery of coke induced a similar condition. At producing centers a car shortage still obtains, unabated up to the present by the return of the railways to private ownership. No coke is available on contract or for immediate delivery at the prevailing government price, although it is stated that some consumers obliged to seek spot coke were able to secure it at a premium. A suspicion is expressed in some quarters that coke production might be considerably improved by the free recognition of higher prices. The shortness of supply has served to weaken the influence of the fuel administration's control over coke prices. In New England, it is stated that by-product producers are selling freely to foundries at $13.95 for second half delivery.

Prices of Raw Materials for Foundry Use

CORRECTED TO MARCH 6

Iron		Scrap	
No. 2 Foundry, Valley	$43.00	Heavy melting steel, Valley	$27.00 to 27.25
No. 2 Southern, Birmingham	40.00 to 41.00	Heavy melting steel, Pittsburgh	27.50 to 28.00
No. 2 Foundry, Chicago	43.00 to 45.00	Heavy melting steel, Chicago	23.50 to 24.00
No. 2 Foundry, Philadelphia	45.35 to 46.10	Stove plate, Chicago	34.50 to 35.00
Basic, Valley	42.00 to 43.50	No. 1 cast, Chicago	42.00 to 42.50
Malleable, Chicago	43.50	No. 1 cast, Philadelphia	40.00 to 41.00
Malleable, Buffalo	46.25	No. 1 cast, Birmingham	31.00 to 33.00
Coke		Car wheels, iron, Pittsburgh	41.00 to 42.00
Connellsville foundry coke	7.00	Car wheels, iron, Chicago	35.50 to 36.00
Wise county foundry coke	8.25	Railroad malleable, Chicago	33.50 to 34.00
		Agricultural malleable, Chicago	33.50 to 34.00

Production Increases

February showed an increase in daily production of pig iron over January although the short month operated to reduce the total tonnage. According to *The Iron Trade Review*, the February production was 2,973,859 gross tons, or an output of 102,547 tons per day in February, a gain of 5374 tons over the previous month. This is an improvement of 5.37 per cent. Merchant iron with 714,118 tons showed a loss of 2456 tons as compared with January's total. The average for February was 24,625 tons, a gain of 1510 tons per day or 9.37 per cent over the first month of the year. There was a net gain of 12 stacks producing merchant iron during the past month. Prices on pig iron seem to be stabilized as little change is noted over the previous two weeks. The prevailing sentiment both among producers and consumers seems to hold that prices have reached a reasonable level. The demand continues steady, but with little except off grade and resale available for immediate delivery. Practically every producer is behind on delivery, and some still are shipping iron on unfilled 1919 orders. Some foundrymen are anxious to place their entire requirement for the year, as they apprehend a serious shortage during the last of 1920. This assumption is based upon the tremendous volume of business now on the books of practically all foundries and the great expansion in plant capacity which is under way or contemplated.

New Factor Enters

An unprecedented condition has confronted a large number of foundries during the past month. Difficulties attending the delivery of coke, the shortage of gas, particularly natural gas, and the wide use of oil instead of coal in locomotives and steamships has brought about a great increase in the demand for fuel oil. Steel foundries, using oil in open-hearth furnaces have become larger buyers during the past few months. Industrial establishments maintaining annealing ovens, foundries operating nonferrous melting furnaces with oil for fuel, and the great number which use oil-fired ovens for baking cores and molds have met with increasing difficulties in procuring supplies of oil, due to the reasons stated. Producers of fuel oil report an actual shortage in the face of increasing demand. Many plants which contracted for their supplies through brokers rather than from the refiners directly, have been practically unable to secure deliveries. A great number of users in the East and through the central states are dependent upon fuel made from crude oil produced or sold through agencies in Pennsylvania. These view with apprehension a recent announcement of the Seep Purchasing Agency, which it is said controls a great part of the crude oil sold to independent and nonproducing manufacturers in this territory. The announcement states that after March 16 crude oil will not be furnished to independent refiners. This probably will mean a further restriction of the supply and may lead to greater difficulties in securing delivery upon fuel oil now on contract. An increase in the supply from southern refiners ,it is hoped may relieve the shortage, particularly when coke, coal and gas become easier.

Activity Grows

Railway inquiries in large volume are at hand. While the ability of the roads to finance their requirements still is in doubt, indications point to large order for all classes of railway equipment. Practically all foundry lines continues to be busy to capacity. Higher prices for nonferrous products are prophesied. Prevailing New York quotations on nonferrous metals follow: Copper, 18.25c to 18.37½c; lead, 9.37½c; tin, 61.00c; antimony, 11.75c to 12.00c; aluminum, No. 12 alloy, producers' price 31.50c, and open market, 30.00c to 31.50c. Zinc is 8.62½c to 8.65c, St. Louis.

Comings and Goings of Foundrymen

J. H. BICKLEY recently became superintendent of the Scott foundry department of the Reading Iron Co., Reading, Pa. Previous to this Mr. Bickley was chief engineer of the Danville Iron Works, Danville, Pa., His experience includes work in the engineering departments of Jones & Laughlin, Pittsburgh, and W. H. Wood, Media, Pa. James J. Zimmerman who was formerly connected with the engineering department of the Cambria Steel Co. has been named assistant to Mr. Bickley at the Reading Iron Works.

Samuel Wallace, Jeanette, Pa., heads a purchasing syndicate which recently purchased a foundry for the manufacture of pipe and plumbers' fittings.

Franklin G. Smith, president of the Osborn Mfg. Co., Cleveland, has been elected a director of the Cleveland Trust Co., of that city.

L. B. Bennett has been made foundry manager for the Elevator Supplies Co., Inc., Hoboken, N. J., which operates one of the largest foundries in that district.

Harry F. Busch has resigned his position with the Chapman Valve Mfg. Co., Indian Orchard, Mass., to become superintendent of a foundry in Gardner, Mass.

William H. Doherty, formerly connected with the Reading Steel Castings Co., Reading, Pa., has joined the sales force of the Connecticut Electric Steel Co., Inc., Hartford, Conn.

H. A. Neel, metallurgist, Michigan Steel Casting Co., Detroit, addressed a joint meeting of Cleveland chapter of the American Steel Treaters' society and the Steel Treating Research society, March 1, on the subject of steel castings standards.

Rudolph Wegelin, who until recently was connected with Joubert & Goslin Machine & Foundry Co., Birmingham, will have charge of the new gray-iron foundry being erected by the Dixie Brass & Foundry Co., of that city.

F. C. Sullivan, vice president of the Braddock Mfg. Co., Braddock, Pa., which recently disposed of its plant to the Wilson-Snyder Mfg. Co., of Pittsburgh, will devote his entire time to the Columbian Foundry Co., Columbiana, O. Mr. Sullivan became president of the latter company in 1917 when the plant was purchased from the United Engineering & Foundry Co. The Columbiana company contemplates extensive improvements and the construction of a new and modern foundry at McKeesport, Pa.

Capt. D. A. Pearson and E. K. Gratwick, A. Harper Sons & Bean, Ltd., Dudley, Worcester, England, recently have visited and inspected a number of the larger automobile manufacturing establishments of this country. They were the guests of the Wilson Foundry & Machine Co. during the past month.

E. Lea Marsh has been made president of the Bay View Foundry Co., Sandusky, O., succeeding A. W. Link, who is retiring from foundry activity this month. Mr. Marsh has been connected with the company for a number of years and has been secretary and treasurer. F. L. Harten is to be secretary and assistant treasurer. Mr. Link was in the foundry business in Erie, Pa., and also in Buffalo, N. Y. He established the Bay View Foundry Co. 16 years ago and has been in active control since that time.

T. J. Dillon has been made president of the Canada Foundry & Forging Co., Ltd., Brockville, Ont., Can., succeeding W. M. Weir, and George P. Graham has been elected vice president. The new directors of the company selected at a recent meeting include: J. T. Dillon, Buffalo; T. J. Dillon, Welland; J. H. A. Briggs and Charles W. Maclean, Brockville; J. A. Mackak, W. M. Weir, Colin O. Cameron and Stephen LeHuray, Montreal; Lieutenant Colonel Monsarrat, Ottawa; Henry Bertram, Dundas; and Lawrence Chamberlain, New York.

Big Field Open for Conveying Machinery

Increasing interest throughout the country in conveying equipment was reflected in papers presented at the first annual meeting of the Material Handling Machinery Manufacturers' association at the Waldorf Astoria hotel, New York City, Feb. 26-27. Installations during the past year exceeded many of the most optimistic predictions, and the buying now in prospect for the relatively near future is said to be greater than ever. While numerous important installations of conveying equipment have been made thus far, it was obvious from reports submitted at the convention that surface of the buying field for this class of equipment had scarcely been scratched. According to A. J. Barnes, Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., who has been for some time past in charge of a special survey for the association, there is now a potential and actual demand for 214,464 units in the industrial field alone. These units, he explained, were such items as industrial trucks, tractors, lift trucks, industrial locomotives, portable cranes, portable conveyors and detached electric hoists. Practically only 5 per cent of the plants in the country are extensively employing these units, Mr. Barnes asserted. He further stated that but 35 per cent of the manufacturers are familiar with mechanical handling equipment and its function, and that the remaining 65 per cent were entirely unfamiliar with the details of even the lesser types of such machinery. Thirty per cent of the manufacturers in the iron, steel and metalworking industry cannot mention the names of a manufacturer of plant transportation equipment. Under this head, Mr. Barnes specifically referred to such units as trucks, tractors, conveyors, etc.

The following members were elected to the board of governors: F. W. Hall, Sprague works of the General Electric Co., New York; H. W. Fairbanks, Northern Engineering Co., Detroit; J. C. Walter, Alvey-Ferguson Co., New York; W. F. Ferrill, Lamson company, Boston; R. W. Scott, Otis Elevator Co., New York; D. V. Jacobs, Watson Elevator Co., New York; L. C. Brown, Elwell-Parker Electric Co., New York; Roy Owens, Lakewood Engineering Co., Lakewood, O.; Fred Stadelman, Wellman-Seaver-Morgan Co., Cleveland; Thomas Robins, Robins Conveying Belt Co., New York; G. O. Helnstaedter, Hyatt Roller Bearing Co., New York; and C. W. Miller, Jeffrey Mfg. Co., Columbus, O. The board, at its March meeting, will elect officers of the association for the ensuing year.

The Easton Car & Construction Co., Easton, Pa., has opened a branch office in the Penobscot building, Detroit. H. H. Siff has been placed in charge.

Lectures to Students

J. D. Wise, mechanical engineer, the Osborn Mfg. Co., Cleveland, on Feb. 19, addressed the students in foundry practice of Pratt Institute, Brooklyn. He presented an interesting series of views illlustrating the various uses of molding machines and indicated the value of power machines as compared with hand machines for certain work. Views of the tunnel sections for the Hudson tubes were shown and explanation given of the method of casting. Mr. Wise pointed out how a slight change in the design of these sections, without damage to their construction or strength, would have simplified the casting operation and speeded up the work considerably. He urged greater consideration on the part of designers for the problems of the foundrymen.

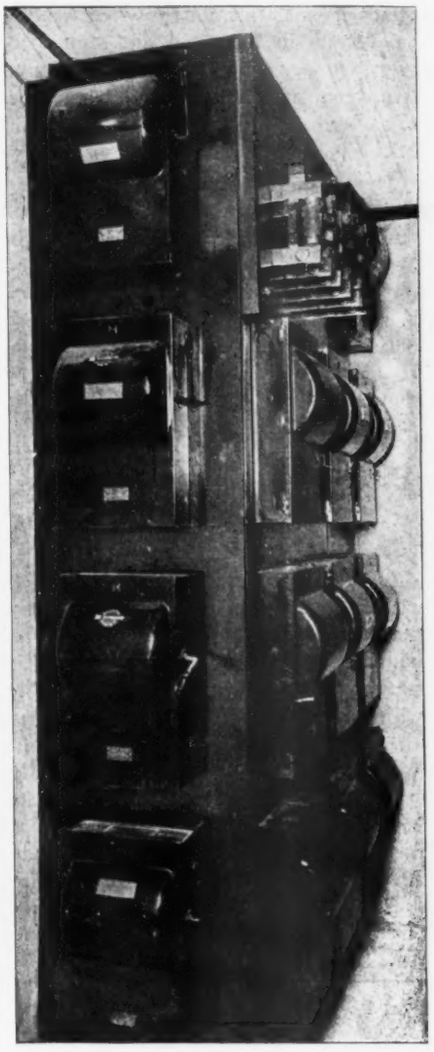
Silica Sand Output Drops

The Portage Silica Co., Youngstown, O., in its annual report for 1919 reflects irregular foundry operations for early in the year. The company produced 87,300 tons of silica sand and shipped 110,000 tons, drawing on stock piles for 23,000 tons. Both production and shipments are shown to be under the 1918 record. Ninety per cent of the company's output consists of silica sand for steel molding and sand blasts, cores, filters, traction sand, and similar uses. Directors and officers were reelected as follows: Directors J. G. Butlet Jr., E. E. Klooz, J. B. Chambers, Fred R. Kanengeiser, G. G. Treat, Henry A. Butler and C. E. Hoffmaster. Officers J. G. Butler Jr., president and treasurer; E. E. Klooz, vice president and general manager; J. B. Chambers, vice president, and L. R. Farrell, secretary and sales manager.

Refractory Cement For Firebrick Walls

The maintenance of furnace linings is a large item in the cost of production; not only must the cost of repairs and renewals be considered but the decreased production owing to the lost time. Fire clay will disintegrate and fall out of the joints between the fire brick allowing the heat and gases to penetrate the wall and shorten its life. In many cases an arch or side wall is lost due to the clay becoming loose around the roof bricks. When it falls it weakens the whole structure. Fire clay in the joints becomes loose from constant expansion and contraction and permits small particles to work in between the spaces. Eventually the openings become large enough to weaken the construction or permit the circulation of gases, resulting in the ruin of the structure.

The McPhee Cement Co., Scranton, Pa., has developed a high temperature cement to be used for bonding fire brick, patching and repairing linings, which it is claimed will give a bond that is air and gas tight and having the same co-efficient of expansion and contraction as the bricks themselves. Among the claims set forth for the cement are that it will form a lasting union between the fire bricks, sets at normal temperature and holds its strength up to 3000 degrees Fahr. It can be put under heat while wet without injury. It is said that it withstands the cutting action of flame and may be used as a coating or wash to smooth and harden the surface of a furnace lining. It can be used for making special shapes such as hearths for high speed tool furnaces, bottoms for annealing furnaces, and also can be used for a binder in making rammed linings like bridge walls or side walls for furnaces, or for entire linings when mixed with crushed refractories.



FOURTEEN SAFETY SWITCHES MOUNTED ON A SINGLE STEEL PANEL BOARD

Dead Front Switchboard Promotes Safety

One of the results of the increasing labor shortage is the employment by industrial plants of men and women having no electrical experience and therefore the question of protecting this class of workers from electrical hazards is of paramount importance.

Dead front switchboards already have found a broad application in industrial installations where electricity is employed as the motive power. They furnish a measure of protection to the inexperienced operator by providing a centralized control for starting motors and miscellaneous power circuits. The accompanying illustration shows 14 safety switches made by the Square D Co., Detroit, mounted on steel panel boards.

This type of board, it is claimed, has many advantages; among them being that it can be constructed by any responsible electrical contractor. The materials used consist chiefly of pipe or angle irons, pipe clamps, conduit, steel panel plates and the safety switches themselves. Switches that are already individually installed on motors are easily convertible to a central power panel, and panels already mounted easily can be changed for individual drives.

German Aluminum Shows Increased Production

At the end of the war, the substitution of aluminum for copper in Germany had raised the total estimated annual consumption to about 32,000 metric tons. The preparation of alloys, the manufacture of motor cars, trucks, machinery and utensils accounted for an estimated annual consumption for these purposes alone of 16,000 metric tons; manufacture of aircraft explosives, heavy machinery, etc., required an additional 4000 tons and 12,000 tons were absorbed by electrical apparatus, fixtures and machinery. These figures are taken from a technical study by Herr Richard Troger of Zehlendorf, which has just been printed and embodied in a report recently received from Commercial Attache Paul L. Edwards, The Hague.

The annual aluminum consumption before the war was only 10,000 tons and in 1904 it was only 2000 tons. To provide for the possible contingency of the war lasting a long time, several new aluminum factories were erected. As a result, Germany's aluminum production has increased about forty fold during the war, as compared with a three-fold increase

of the whole world production during the same period. Herr Troger gives the figures in the accompanying table.

Country	Annual production before the war	Increase	Total annual production at present
	(In metric tons)		
Germany	1,000	39,000	40,000
Austria-Hungary, Switzerland....	11,000	14,000	25,000
France	18,000	2,000	20,000
England	7,500	4,500	12,000
Italy	1,000	6,000	7,000
Norway	1,500	14,500	16,000
United States and Canada	28,000	45,000	73,000
Total	68,000	125,000	193,000

The construction of new aluminum factories was made the subject of urgent representation by the war raw materials division early in 1915. The first factory was actually in operation in the latter part of 1915. This factory and also the factories built subsequently all were financed by private capital. The following three concerns which sprang up in 1915-1916 own practically all the factories now in operation: The Erftwerk-Aktien-Gesellschaft, the Vereinigte-Aluminumwerke Aktien-Gesellschaft, and the Innwerke Bayerische Aluminum Aktien-Gesellschaft. The construction of these factories was unusually expensive on account of the fact that it took place in war time.

The owners seem to be in considerable doubt as to whether or not they will be able to compete with foreign factories, now that the war is over, and whether the demand for aluminum will continue on a sufficient scale to keep them profitably supplied with orders, now that copper may be again imported from abroad.

There appears to exist in Germany a feeling that the aluminum factories are doomed to failure unless measures are taken to protect the industry from foreign competition, and unless a way is found for maintaining the use of aluminum as a substitute for copper. The fact that Germany, before the war, did not develop an aluminum-manufacturing industry of sufficient dimensions for home consumption requirements seems to be due principally to the fact that she possessed no ore mines which could be worked profitably in competition with foreign ores. German ores are of a low grade. The possibility of importing French bauxite or other ore is being considered. In estimating future consumption of aluminum in Germany one of the most uncertain factors is extent to which the use of aluminum will be abandoned. This action will depend considerably upon relations between the prices of the two metals. Herr Troger believes that something should be done to regulate the price, not only of aluminum, but also of copper. He advocates the establishment of a concern with a monopoly of wholesale trade in imported and domestically produced copper and aluminum. This concern would be modeled after the German metal concerns that did business before the war.

Herr Troger estimates that during the next few years the cost of production of aluminum in Germany will be about 15 per cent higher than the import price, and of copper about 7 per cent higher. These estimates are based on normal rates of exchange. He suggests a protective duty of about 0.50 mark per kilogram for the present for both articels.

Vibrator is Unit With Core Bench

A light, all steel coremaker's bench with vibrator attachment developed by the Malleable Iron Fittings Co. The bench is rigidly constructed and is supported upon a reinforced table which may be bolted to the floor. As may be seen in the accompanying illustration it is strongly and rigidly built. The distinctive feature of the bench is that a rectangular space in the center is taken up by a stiff plate having a vibrator attached directly to the bottom actuated by bearing down on the plate. In this way any small core box may be rammed on the plate and by setting the vibrator in motion before lifting the box a clean draw is assured.

CORE BENCH FITTED WITH AN EASILY ACTUATED VIBRATOR PLATE

Offers Record System For Grinding Wheels

In a recent issue of Grits and Grinds, a monthly bulletin issued by the Norton Co., Worcester, Mass., a grinding wheel record system for the foundry is recommended. The cost of grinding, it is stated, is an important item in the grinding room of a foundry. No conclusive study can be made of this problem unless proper records are kept. The installation and use of a satisfactory system meeting all the requirements is outlined as follows:

Whenever a wheel is given out from the stock room, a card is issued to the grinding foreman. He should enter on each card: (1) The name and order number of the wheel. (2) The machine number. (3) The date and time the wheel is mounted. (4) The date and time the wheel is taken off. (5) The diameter of the wheel when taken off. (6) Tonnage of castings ground. Where a standard part is ground the number of pieces is also to be noted.

The figures are transferred to a permanent record book in which they may be classed by operators. In addition there is a sheet showing the figures for all wheels used each month.

From figures secured at several plants it seems reasonable to assume that for a swing frame grinding machine the overhead is calculated at about $1.00 an hour and the wheel cost amounts to approximately $0.20 per hour, or one-fifth of the overhead. It easily can be figured that with labor at $0.50 an hour an increase in production of 10 per cent is as important in reducing final wheel cost as an increase of 100 per cent in wheel life, assuming that the production in the case of the increased wheel life would remain constant. As a matter of fact it would not remain constant due to the higher overhead per ton of castings. It is therefore much more desirable to endeavor to increase the production per hour at the expense of wheel life than to try to increase wheel life at the expense of production. Of course there is a limit, softer than which it would be impossible to go. By classifying the results the operator has obtained with the

same wheel in the past, one may easily determine whether the wheel that is being tested is hard or not. If the tonnage per hour has not decreased, it can safely be said that the wheel is cutting satisfactorily.

Foundry Associations Hold Joint Session

Foundry associations in the metropolitan district met Thursday, Feb. 26, under the auspices of the Gray Iron Club of New York, at the Building Trades Exchange building, 34 West Thirty-third street, New York. In addition to the members of the Gray Iron club, large representations were present from the Newark Foundrymen's association, the Metropolitan Brass association and the Associated Foundry Foremen of New York and vicinity. Following a dinner, J. M. Graham, Elevator Supply & Repair Co., Hoboken, president of the Gray Iron club, who presided as toastmaster, welcomed the members and their guests and in response, Arthur E. Barlow, of Barlow Foundry, Inc., Newark, spoke on the value of co-operation. The speaker of the evening was Dr. Richard Moldenke, whose subject was "Metallurgy." Dr. Moldenke spoke extensively on cupola practice and the effect of various ingredients on metal mixtures, and he traced the connection between casting troubles such as blow holes, cold shuts, etc., to the mixtures and the fuel employed.

Organize New Foundry

A new foundry has been organized to be known as the Attica Foundry Co., Attica, Ind., to engage in the manufacture of gray iron, brass and aluminum castings. The active officers of the new company are: M. J. McConomy, treasurer; W. B. Barber, general manager; Bert Reeves, general superintendent and W. J. Davis, assistant superintendent.

The Aberthaw Construction Co., Boston, is doing investigational work cooling the effect of vibration upon industrial equipment and workmen. The data and results developed by this investigation will be published and will be made available to manufacturers.

What the Foundries Are Doing

Activities of the Iron Steel and Brass Shops

Gus Lagerquist, 516 Third street, Minneapolis, contemplates the erection of a foundry.

The Oklahoma Foundry Products Co., Enid, Okla., will equip a plant.

The General Fire Extinguisher Co. is building a gray iron foundry at Warren, O.

Erection of an extension to its plant is planned by the Columbus Malleable Iron Co., Columbus, O.

Bids are being taken for the erection of a foundry for the Kendallville Foundry Co., Kendallville, Ind.

The Indiana Foundry Co., Muncie, Ind., is building a new plant, 150 x 200 feet.

The Flint Foundry Co., Flint, Mich., is reported planning to erect a new plant.

The General Motors Corp. contemplates the erection of a malleable iron foundry at Essexville, Mich.

The Lynchburg Foundry Co., Anniston, Ala., will start operations shortly. It has been closed for the past two years.

Ground has been broken by the Kohler Co., Kohler, Wis., for the erection of a gray iron foundry, 200 x 295 feet.

The plant of the Milwaukee Die Casting Co., 297 Fourth street, Milwaukee, recently was damaged by fire.

O. B. North & Co., Inc., New Haven, Conn., has let a contract for the erection of a foundry, 37 x 107 feet.

The foundry of Reid & Brown, 61 Esplanade street, Toronto, Ont., recently was damaged by fire. It will be rebuilt.

The Dixie Brass & Foundry Co., Birmingham, Ala., is erecting an addition to its plant, as well as constructing a gray iron foundry unit.

D. P. Sperry & Co., Batavia, Ill., are having plans prepared for the erection of a foundry, 60 x 100 feet.

M. L. Oberdoifer, 804 East Water street, Syracuse, N. Y., is having plans prepared for the erection of a foundry addition.

The Lovell Mfg. Co., Thirteenth and French streets, Allentown, Pa., contemplates the erection of a plant, 75 x 145 feet.

The Modern Foundry Co., 601 Marburg avenue, Cincinnati, contemplates the erection of a molding room, 38 x 80 feet.

The Greenville Iron Works, Greenville, S. C., contemplates the erection of a machine shop, 50 x 120 feet, and a foundry, 54 x 130 feet.

The Monarch Foundry Co., 895 Greenwood avenue, Detroit, has awarded a contract for the erection of a foundry building, 100 x 200 feet.

The Rochester Machine & Foundry Co., Rochester, Mich., is having plans prepared for the erection of a foundry building, 60 x 128 feet.

Contracts have been awarded by the Gisholt Machine Co., Madison, Wis., for the erection of an addition to its gray iron foundry, 115 x 200 feet.

A permit to erect a plant addition has been taken out by the Advance Pattern & Foundry Co., Chicago.

The Canton Pattern & Mfg. Co., Canton, O., has been incorporated with $100,000 capital, by T. M. Dubs, E. R. Starkey and others.

The Burt Foundry Co., Toledo, O., contemplates the erection of an addition to its foundry, 60 x 100 feet.

The Emporium Pipe & Foundry Works, Emporium, Pa., has been incorporated with $75,000 capital, by C. J. Goodman, C. W. Rishell and Josiah Howard.

J. C. Gardner, Brockville, Ont., will head a company, financed by American and Canadian capital, which will engage in the foundry business.

The Machinery & Foundries, Ltd., Brockville, Ont., which was recently incorporated with $250,000 capital, will start work shortly on the erection of a plant.

The Cincinnati Fixture Foundry Co., Cincinnati, recently was incorporated with $30,000 capital, by P. T. Fruechtemeyer, W. G. Brown and others.

The Barnett Foundry & Machine Co., Lyons avenue, Irvington, N. J., has had plans prepared for the erection of a plant addition.

The O'Neil Iron Works, Inc., Buffalo, has been purchased by Buffalo interests headed by John M. Hall. The plant includes a modern foundry.

Capitalized at $10,000, the Albra Castings Co., Cleveland, recently was incorporated by R. L. Welsh, S. F. Dolezal and others.

The Manufacturers' Foundry Co., Cleveland, recently was incorporated with $500,000 capital, by William Finn, A. Kyle and others.

The Pittsburgh Bronze Casting Co., Pittsburgh, recently was incorporated with $50,000 capital, by Carl P. Seyler, Carl J. Setler and George M. Hosack.

Erection of an addition to its foundry, 100 x 150 feet, is contemplated by the West Steel Casting Co., 805 East Seventieth street, Cleveland.

Erection of an addition to its plant, 50 x 200 feet, is contemplated by the Waukesha Foundry Co., Waukesha, Wis., manufacturer of gray iron castings.

The Peoria Malleable Castings Co., Peoria, Ill., has increased its capital from $175,000 to $250,000 and will enlarge its plant.

The Rockford Malleable Iron Works, Rockford, Ill., has awarded a contract for the erection of a core room, 44 x 52 feet.

The Acme Aluminum & Brass Works, 420 South Harding street, Indianapolis, will increase its capital, and plans to enlarge its plant.

Contracts have been awarded for the erection of an addition to the plant of the Standard Steel Casting Co., 910 South Michigan avenue, Chicago.

The Carlisle Foundry Co., Carlisle, Pa., recently was incorporated with $50,000 capital, by C. S. Brinton, Thomas McDonald and N. C. Righter.

Contracts have been awarded for the erection of additions to the plant of the Elmira Foundry Co., Elmira, N. Y.

Capitalized at $10,000, the Moulds Brass Foundry Co., Benton Harbor, Mich., recently was incorporated by William Moulds and others.

The Alloy Foundry & Machine Corp., New Rochelle, N. Y., recently was incorporated with $50,000 capital, by W. E. Wolheim, J. Grave and A. C. Wakeling.

Erection of a plant, two stories, 40 x 100 feet, is being planned by the Bridgeport Pattern Model Co., Bridgeport, Conn.

W. Niblock, J. R. Nelson and G. A. Brown were named as the incorporators of the Pattern Mfg. Co., Buffalo, which was recently chartered with $100,000 capital.

Capitalized at $50,000, the Phelps Foundry Co., Phelps, N. Y., recently was incorporated to engage in a general foundry business, by W. R. Shavor, T. Jones and C. P. Downs.

The Caroline Foundry Co., 723 South Caroline street, Baltimore, has awarded contracts for the erection of an addition to its plant, 60 x 106 feet.

A large foundry company being organized at Decatur, Ill., has an option on the plant of the

Alfo Products Co. In addition to the present plant an additional structure will be erected.

A company is being formed at Muncie, Ind., which plans to erect a plant, 75 x 100 feet. Those interested can be reached through Judge W. A. McClellan, Vettet building, Muncie.

The Mont-Claire Foundry Co., Philadelphia, recently was incorporated with $50,000 capital, by C. M. Borton, Horace E. Frick and Randolph Sailer, 929 Chestnut street.

The East Mfg. Co., Manitowoc, Wis., capital stock $25,000, has been incorporated by J. P. Eastman and others, to manufacture brass hose couplings and other brass goods.

To accommodate equipment it has already purchased, the Strong Steel Foundry Co., Buffalo, recently awarded a contract for the construction of a 100-foot extension to its plant.

The Gulf Iron & Machine Co., Galveston, Tex., recently was incorporated with $7500 capital to operate a foundry and machine shop, by P. E. Hanson, C. G. Guebe and S. G. Allen.

Roy Adams, care of the Somerset Garage & Machine Co., Somerset, Pa., is having plans prepared for the erection of a foundry and machine shop, 50 x 180 feet.

Architect J. F. Ancona, 304 Cutler building, Rochester, N. Y., is preparing plans for the erection of a machine shop and foundry. The name of the owner will be announced later.

Fire recently damaged the plant of the Chalmers Pump & Mfg. Co., Lima., O. Plans now are being prepared for the erection of a new plant which will be about double the size of the old one.

Capitalized at $75,000, the Eastham Soil Pipe & Foundry Co., Anniston, Ala., recently was organized by J. M. Eastham, O. J. Angle and M. S. Miller.

Moffats, Ltd., Toronto, Ont., recently was incorporated to manufacture iron, steel, metals, castings, etc., with $1,000,000 capital, by James L. Ross, room 43, King street, Arthur B. Mortimer and others.

The Olympia Foundry Co., Olympia, Wash., recently was incorporated by W. L. Phillips, William Allard and others, to produce gray iron castings. It will add brass castings to its products after it is established.

Fuller & Sons Mfg. Co., Kalamazoo, Mich., has purchased 10 acres adjoining its plant on which it will erect an office building, drop forge plant and additions to its factory and foundry. Frank D Fuller is president of the company.

The W. C. Hopson Co., Grand Rapids, Mich., recently was incorporated with $150,000 capital, to engage in the manufacture of foundry goods and castings. William C. Hopson and Dilman Witmer are among the incorporators.

The Northwest Foundries, Inc., Villa and Valentine streets, Rochester, N. Y., has had plans prepared for the erection of a gray iron foundry, 197 x 250 feet. George A. Hetzler is secretary and general manager of the company.

Capitalized at $100,000, the New England Foundries, Inc., Boston, recently was chartered to operate a foundry and machine shop, by E. A. Tutein, Winchester, Mass., Herbert A. White, Stoughton, Mass., and A. H. Cahill Malden, Mass.

Charles E. Coleman, William S. Porster, Rochester, Pa., and Clifford S. Marshall, Corapolis, Pa., are the incorporators of the Beaver Valley Alloy Foundry Co., Monaca, Pa., which was recently chartered with $30,000 capital.

The A. Plamondon Mfg. Co., 24 North Clinton street, Chicago, has awarded a contract for the erection of a plant, 100 x 500 feet, to be devoted to the manufacture of machine shop and foundry equipment.

The Ajax Foundry & Machine Co., Anniston, Ala., which recently was organized, contemplates the erection of a foundry and machine shop, 60 x 200 feet. The company is capitalized at $125,000. J. B. Carrington is president.

Acid steel castings will be manufactured by the Oklahoma Steel Castings Co., which was recently incorporated at Tulsa, Okla., with $100,000 capital. The new company has purchased a site and will let contracts shortly for the erection of the plant buildings.

The Alemite Die Casting & Mfg. Co., Chicago, has purchased a site on which it will build a plant containing about 100,000 square feet of floor space. The products of the plant will consist of die and mold castings and automobile accessories. John S. Guilberg is president of the company.

An additional foundry will be built by the Williams & White Co., Moline, Ill., as soon as weather permits. Products will consist of castings ranging up to 75 tons. The plant will be equipped with one 40-ton, one 20-ton and three 10-ton cranes. The plant will consist of two buildings, the main foundry being 150 x 325 feet with connecting material shed and craneway, 60 x 400 feet.

The Columbiana Foundry Co., Columbiana, O., plans to increase its capital to $150,000 and will erect a gray iron foundry at McKeesport, Pa. A contract has been awarded for the erection of the plant, which will consist of a foundry building, 100 x 300 feet, and a pattern storage and office building, 25 x 150 feet. It will be modernly equipped for the production of gray iron, semisteel and brass castings.

Because of the rapid increase of business the Vanango Bronze Metal Co., Franklin, Pa., manufacturer of copper-alloyed and aluminum castings, is erecting an additional temporary building, 30 x 65 feet. Melting will be done in five crucible furnaces and one 500-pound, open-flame, oil-fired furnace, which will give a melting capacity of two tons a day. Cleaning will be done by sandblast equipment and acid bath. The company is operated by F. J. Clark and W. E. Carmer.

New Trade Publications

HANDLING DEVICES.—A leaflet is being distributed by the W. S. Rockwell Co., New York, in which handling devices used in the heat-treatment room are described. Another leaflet issued by the company is devoted to describing and illustrating the plate and angle heating furnace equipment of a typical shipyard. Both bulletins are interesting.

AIR-LIFT PUMPING.—A bulletin which calls attention to air-lift pumping, is being circulated by the Union Steam Pump Co., Battle Creek, Mich. This system consists of lifting water by means of compressed air, and is generally employed where conditions are such that it is impractical to use a mechanical pump. The booklet goes into the subject in detail, and a number of illustrations are given.

TORCHES.—A 4-page folder has been published by the Mahr Mfg. Co., Minneapolis, in which torches are described and illustrated. These torches are for use in cupola lighting, ladle drying, mold drying, preheating and general foundry purposes. Any length of flame, ranging from a few inches to five feet, can be obtained. The torches operate on compressed air at any pressure, and burn light fuel oil or kerosene.

ELECTRIC FURNACES.—The Electric Furnace Co., Alliance, O., has published a booklet in which illustrations of electric furnace installations are given. Some of the illustrations show installations in the plants of the Aluminum Co. of America; The Miller Pasturizing Machine Co.; The Hays Mfg. Co.; the Capital Brass Works; The Buick Motor Co.; the Nolte Brass Co.; the Lumen Bearing Co. and many others.

ELECTRIC EQUIPMENT.—The Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has published a 48-page illustrated booklet entitled, "Application of Electricity to the Metallurgical and Chemical Industries." The booklet deals with the electric furnace in the metallurgical industry, and the various electric equipment used in the chemical and electrochemical industries. The concluding chapter of the book contains descriptions of electrical apparatus used in these industries.

DRILL VISE.—A vise designed to firmly clamp and hold an air drill in various accessible positions while repairs, testing and assembling are being done, is described and illustrated in a folder recently published by the Independent Pneumatic Tool Co., Chicago. This vise is made of a flanged upright machine post or stand; a sliding collar adjusts the vise to proper height for convenient working, and located above the collar is a clamp, which swivels on the collar and is held in any position by tightening the clamp screws. Other details are given.

PLANT CONSTRUCTION.—Westinghouse, Church, Kerr & Co., Inc., New York, is circulating a large 4-page folder containing a composite picture of hundreds of plants which the company has erected, and which tend to show the diversified engineering and construction projects on which the company has been engaged. The picture include an automobile plant, a knitting mill, a fertilizer plant, a locomotive terminal, a brass mill, a weave shed, a repair shop, an office building, a power plant, a steel foundry, a powder plant, and buildings used in practically every industry.

CONVEYORS.—Portable belt conveyors are described and illustrated in a 4-page leaflet being circulated by the Portable Machinery Co., Passaic, N. J. These conveyors are designed to handle material horizontally or at a slight incline, and although strong and durable in construction, are light enough to permit their transfer from point to point. According to the folder the maximum conveying capacity of these conveyors is one ton per minute. The frame is made of structural steel angle iron and flats, securely braced and riveted throughout. Other details and specifications are given.

INDUSTRIAL ENGINEERING.—A large 26-page illustrated booklet has been published by William Beardmore & Co., Ltd., Glasgow, Scotland, containing a review of the industrial activities and manufacturing resources of the company, which is a reprint from the *Empire Illustrated*. The article gives a review of the company's war work, tells of its various work, and the resumption of peace time enterprise upon which the company entered after the signing of the armistice. The manufacture of steel at the company's Parkhead works, is described, as are the activities in the rolling mills, the forge department, the steel foundry, wheel and axle department, etc. The company's naval construction works at Dalmur, is described in detail, as is the company's aircraft manufacturing activities, its Mossend Steel Works and its Speedwell Works, at which marine engines are manufactured. The book is profusely illustrated showing interesting parts of the company's various plants and its products.

OIL BURNERS.—The Hauck Mfg. Co., Brooklyn, N. Y., has published a 16-page booklet in which various types of oil burners are described and illustrated. Many of the illustrations show practical applications of these burners to various types of furnaces, and part of the booklet is devoted to sketches showing other purposes to which the burners can be adapted. The oil burners are made in four designs. The atomizing type burns any grade of crude or kerosene oil in connection with compressed air or steam. The positive pressure style atomizes fuel, crude or kerosene oil with pressure from two to 10 pounds supplied by a positive pressure blower. The low pressure style atomizes the oil by using 1½ ounces or more fan blast pressure, and burns fuel, crude, kerosene or refuse oil. The fourth type, known as the vaporizing style, is a self-contained type burner. Oil is forced under pressure of from 10 to 60 pounds to the burner, where it is vaporized. These burners have their own combustion chambers and do not depend upon the furnace or fire brick walls for combustion, as the flame starts from the tip of the burner, according to the booklet.